APPENDIX J

STORMWATER MANAGEMENT SYSTEM

1. STORMWATER CALCULATIONS - INTERIM CONDITIONS
2. STORMWATER CALCULATIONS - CLOSED CONDITIONS
3. NPDES PERMIT

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APPENDIX J.1

STORMWATER CALCULATIONS - INTERIM CONDITIONS

Shaw®

DETERMINATION OF RAINFALL TOTALS AND DISTRIBUTIONS

Shaw®

Shaw® Shaw Environmental, Inc.

Client:	Clinton Landfill, Inc.		
Project:	Clinton Landfill No. 3		
Proj.#:	128017		
Calculated By:	LJC	Date:	9/14/07
Checked by:	JPV	Date:	9/17/07

TITLE: DETERMINATION OF RAINFALL TOTALS AND DISTRIBUTION

Problem Statement

Determine the total rainfall intensity for the 2-year, 25-year and 100-year frequencies. The rainfall intensity for the 25-year and 100-year frequencies is used in the HEC-HMS model to determine rainfall runoff and the 2-year frequency is used in the calculations to determine SCS Lag Time.

Given

Rainfall data was obtained from Bulletin 71 (see attached reference).

Assumptions

Based on the information provided in Bulletin 71, it was assumed that the rainfall distribution of the 1-hour storm for all storm frequencies corresponds to the first-quartile distribution pattern, i.e the heaviest rainfall occurs in the first quarter of the storm event. For the 24-hour storms, a third-quartile distribution pattern is more appropriate.

Results

As shown on Figure 1 of Bulletin 71, DeWitt County is located in the Central Climatic Section. From Table 1 of Bulletin 71, the following conservative total rainfalls were used in the hydrologic analyses.

Recurrence Interval	24-Hour (inches)	1-Hour (inches)
2-Year	3.02	1.42
25-Year	5.32	2.50
100-Year	6.92	3.25

The table below summarizes the cumulative percent rainfall for the first- and third-quartile distributions shown in Table 1 of Bulletin 71. The total rainfall and percentages are entered into the HEC-HMS model and the program multiplies the percentages by the total rainfall to develop a rainfall hydrograph for each storm frequency.

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TITLE: DETERMINATION OF RAINFALL TOTALS AND DISTRIBUTION

	Cumulative Storm Rainfall (percent)	
Cumulative Storm Time (percent)	First Quartile (1-hour Storm)	Third Quartile (24-hour Storm)
5	16	3
10	33	6
15	43	9
20	52	12
25	60	15
30	66	19
35	71	23
40	75	27
45	79	32
50	82	38
55	84	45
60	86	57
65	88	70
70	90	79
75	92	85
80	94	89
85	96	92
90	97	95
95	98	97

1st Quartile Rainfall Distribution

Storm Event	25-year, 1-hour storm event for Clinton Landfill No. 3	
Enter Rainfall Depth (in)	2.50	
Storm Length (hrs.)	1	

Cumulative Storm Rainfall (%)	First Quartile (%)	Time	Cumulative Precipitation (in)
0	0	0:00	0.00
5	16	0:03	0.40
10	33	0:06	0.83
15	43	0:09	1.08
20	52	0:12	1.30
25	60	0:15	1.50
30	66	0:18	1.65
35	71	0:21	1.78
40	75	0:24	1.88
45	79	0:27	1.98
50	82	0:30	2.05
55	84	0:33	2.10
60	86	0:36	2.15
65	88	0:39	2.20
70	90	0:42	2.25
75	92	0:45	2.30
80	94	0:48	2.35
85	96	0:51	2.40
90	97	0:54	2.43
95	98	0:57	2.45
100	100	1:00	2.50

Time Interval (min) 3

3rd Quartile Rainfall Distribution

Storm Event	25-year, 24-hour storm event for Clinton Landfill No. 3
Enter Rainfall Depth (in)	5.32
Storm Length (hrs.)	24

Cumulative Storm Rainfall (%)	Third Quartile (%)	Time	Cumulative Precipitation (in)
0.00	0.00	0:00	0.00
1.39	0.83	0:20	0.04
2.78	1.67	0:40	0.09
4.17	2.50	1:00	0.13
5.56	3.33	1:20	0.18
6.94	4.17	1:40	0.22
8.33	5.00	2:00	0.27
9.72	5.83	2:20	0.31
11.11	6.67	2:40	0.35
12.50	7.50	3:00	0.40
13.89	8.33	3:20	0.44
15.28	9.17	3:40	0.49
16.67	10.00	4:00	0.53
18.06	10.83	4:20	0.58
19.44	11.67	4:40	0.62
20.83	12.50	5:00	0.66
22.22	13.33	5:20	0.71
23.61	14.17	5:40	0.75
25.00	15.00	6:00	0.80
26.39	16.11	6:20	0.86
27.78	17.22	6:40	0.92
29.17	18.33	7:00	0.98
30.56	19.44	7:20	1.03
31.94	20.56	7:40	1.09
33.33	21.67	8:00	1.15
34.72	22.78	8:20	1.21
36.11	23.89	8:40	1.27
37.50	25.00	9:00	1.33
38.89	26.11	9:20	1.39
40.28	27.28	9:40	1.45
41.67	28.67	10:00	1.53
43.06	30.06	10:20	1.60
44.44	31.44	10:40	1.67
45.83	33.00	11:00	1.76
47.22	34.67	11:20	1.84
48.61	36.33	11:40	1.93
50.00	38.00	12:00	2.02
51.39	39.94	12:20	2.13
52.78	41.89	12:40	2.23
54.17	43.83	13:00	2.33
55.56	46.33	13:20	2.46
56.94	49.67	13:40	2.64
58.33	53.00	14:00	2.82

Cumulative Storm Rainfall (%)	Third Quartile (%)	Time	Cumulative Precipitation (in)
59.72	56.33	14:20	3.00
61.11	59.89	14:40	3.19
62.50	63.50	15:00	3.38
63.89	67.11	15:20	3.57
65.28	70.50	15:40	3.75
66.67	73.00	16:00	3.88
68.06	75.50	16:20	4.02
69.44	78.00	16:40	4.15
70.83	80.00	17:00	4.26
72.22	81.67	17:20	4.34
73.61	83.33	17:40	4.43
75.00	85.00	18:00	4.52
76.39	86.11	18:20	4.58
77.78	87.22	18:40	4.64
79.17	88.33	19:00	4.70
80.56	89.33	19:20	4.75
81.94	90.17	19:40	4.80
83.33	91.00	20:00	4.84
84.72	91.83	20:20	4.89
86.11	92.67	20:40	4.93
87.50	93.50	21:00	4.97
88.89	94.33	21:20	5.02
90.28	95.11	21:40	5.06
91.67	95.67	22:00	5.09
93.06	96.22	22:20	5.12
94.44	96.78	22:40	5.15
95.83	97.50	23:00	5.19
97.22	98.33	23:20	5.23
98.61	99.17	23:40	5.28
100.00	100.00	0:00	5.32

Time Interval (min) 20

1st Quartile Rainfall Distribution

Storm Event	100-year, 1-hour storm event for Clinton Landfill No. 3
Enter Rainfall Depth (in)	3.25
Storm Length (hrs.)	1

Cumulative Storm Rainfall (%)	First Quartile (%)	Time	Cumulative Precipitation (in)
0	0	0:00	0.00
5	16	0:03	0.52
10	33	0:06	1.07
15	43	0:09	1.40
20	52	0:12	1.69
25	60	0:15	1.95
30	66	0:18	2.15
35	71	0:21	2.31
40	75	0:24	2.44
45	79	0:27	2.57
50	82	0:30	2.67
55	84	0:33	2.73
60	86	0:36	2.80
65	88	0:39	2.86
70	90	0:42	2.93
75	92	0:45	2.99
80	94	0:48	3.06
85	96	0:51	3.12
90	97	0:54	3.15
95	98	0:57	3.19
100	100	1:00	3.25

Time Interval (min)	3

3rd Quartile Rainfall Distribution

Storm Event	100-year, 24-hour storm event for Clinton Landfill No. 3
Enter Rainfall Depth (in)	6.92
Storm Length (hrs.)	24

Cumulative Storm Rainfall (%)	Third Quartile (%)	Time	Cumulative Precipitation (in)
0.00	0.00	0:00	0.00
1.39	0.83	0:20	0.06
2.78	1.67	0:40	0.12
4.17	2.50	1:00	0.17
5.00	3.00	1:12	
5.56	3.33	1:20	0.23
6.94	4.17	1:40	0.29
8.33	5.00	2:00	0.35
9.72	5.83	2:20	0.40
10.00	6.00	2:24	[illegible]
11.11	6.67	2:40	0.46
12.50	7.50	3:00	0.52
13.89	8.33	3:20	0.58
15.00	9.00	3:36	
15.28	9.17	3:40	0.63
16.67	10.00	4:00	0.69
18.06	10.83	4:20	0.75
19.44	11.67	4:40	0.81
20.00	12.00	4:48	[illegible]
20.83	12.50	5:00	0.86
22.22	13.33	5:20	0.92
23.61	14.17	5:40	0.98
25.00	15.00	6:00	1.04
26.39	16.11	6:20	1.11
27.78	17.22	6:40	1.19
29.17	18.33	7:00	1.27
30.00	19.00	7:12	
30.56	19.44	7:20	1.35
31.94	20.56	7:40	1.42
33.33	21.67	8:00	1.50
34.72	22.78	8:20	1.58
35.00	23.00	8:24	
36.11	23.89	8:40	1.65
37.50	25.00	9:00	1.73
38.89	26.11	9:20	1.81
40.00	27.00	9:36	
40.28	27.28	9:40	1.89
41.67	28.67	10:00	1.98
43.06	30.06	10:20	2.08
44.44	31.44	10:40	2.18
45.00	32.00	10:48	
45.83	33.00	11:00	2.28
47.22	34.67	11:20	2.40

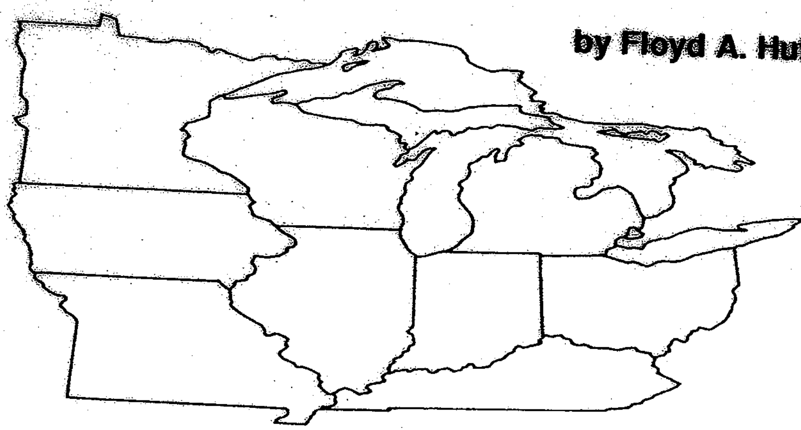
Cumulative Storm Rainfall (%)	Third Quartile (%)	Time	Cumulative Precipitation (in)
48.61	36.33	11:40	2.51
50.00	38.00	12:00	2.63
51.39	39.94	12:20	2.76
52.78	41.89	12:40	2.90
54.17	43.83	13:00	3.03
55.00	45.00	13:12	
55.56	46.33	13:20	3.21
56.94	49.67	13:40	3.44
58.33	53.00	14:00	3.67
59.72	56.33	14:20	3.90
60.00	57.00	14:24	
61.11	59.89	14:40	4.14
62.50	63.50	15:00	4.39
63.89	67.11	15:20	4.64
65.00	70.00	15:36	
65.28	70.50	15:40	4.88
66.67	73.00	16:00	5.05
68.06	75.50	16:20	5.22
69.44	78.00	16:40	5.40
70.00	79.00	16:48	
70.83	80.00	17:00	5.54
72.22	81.67	17:20	5.65
73.61	83.33	17:40	5.77
75.00	85.00	18:00	5.88
76.39	86.11	18:20	5.96
77.78	87.22	18:40	6.04
79.17	88.33	19:00	6.11
80.00	89.00	19:12	
80.56	89.33	19:20	6.18
81.94	90.17	19:40	6.24
83.33	91.00	20:00	6.30
84.72	91.83	20:20	6.35
85.00	92.00	20:24	
86.11	92.67	20:40	6.41
87.50	93.50	21:00	6.47
88.89	94.33	21:20	6.53
90.00	95.00	21:36	
90.28	95.11	21:40	6.58
91.67	95.67	22:00	6.62
93.06	96.22	22:20	6.66
94.44	96.78	22:40	6.70
95.00	97.00	22:48	
95.83	97.50	23:00	6.75
97.22	98.33	23:20	6.80
98.61	99.17	23:40	6.86
100.00	100.00	0:00	6.92

Bulletin 71

(MCC Research Report 92-03)

RAINFALL FREQUENCY ATLAS OF THE MIDWEST

by Floyd A. Huff and James R. Angel



Midwestern Climate Center
Climate Analysis Center
National Weather Service
National Oceanic and Atmospheric Administration

and

Illinois State Water Survey
A Division of the Illinois Department of Energy and Natural Resources

1992

(MCC) with Stanley Changnon and Peter J. Lamb as the co-principal investigators. The work was continued and completed under the general direction of Kenneth Kunkel, present MCC Director.

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John Brother and Linda Hascall supervised the extensive drafting work required for the report. Jean Dennison typed and assembled the report, which Eva Kingston edited and formatted.

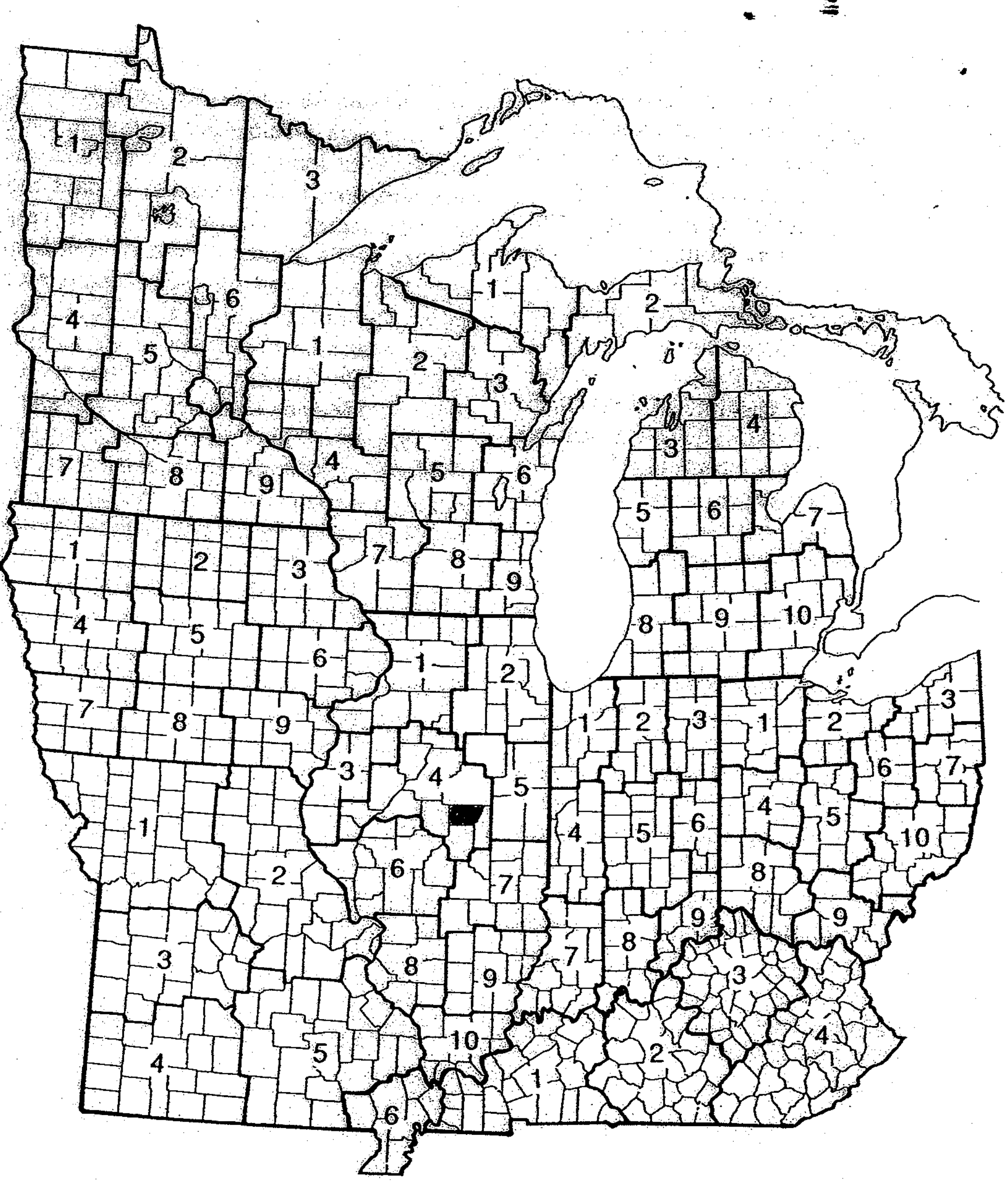


Figure 1. Climatic sections for the Midwest

Table 1. Continued

Rainfall (inches) for given recurrence interval

Section	Duration	2-month	3-month	4-month	6-month	9-month	1-year	2-year	5-year	10-year	25-year	50-year	100-year
04	10-day	2.10	2.58	2.92	3.43	3.93	4.29	5.12	6.27	7.10	8.19	9.10	10.18
04	5-day	1.77	2.12	2.37	2.78	3.20	3.48	4.17	5.11	5.84	6.96	7.98	9.21
04	72-hr	1.59	1.91	2.12	2.44	2.80	3.05	3.70	4.55	5.26	6.15	7.25	8.16
04	48-hr	1.48	1.76	1.95	2.25	2.58	2.81	3.38	4.19	4.86	5.78	6.62	7.51
04	24-hr	1.39	1.63	1.80	2.04	2.32	2.52	3.02	3.76	4.45	5.32	6.08	6.92
04	18-hr	1.27	1.51	1.66	1.88	2.12	2.28	2.75	3.46	4.09	4.90	5.59	6.37
04	12-hr	1.19	1.40	1.53	1.77	2.01	2.17	2.62	3.27	3.[illegible]7	4.63	5.29	6.02
04	6-hr	1.03	1.21	1.34	1.53	1.74	1.89	2.26	2.82	3.33	3.99	4.56	5.19
04	3-hr	0.89	1.03	1.13	1.30	1.47	1.61	1.93	2.41	2.85	3.41	3.89	4.43
04	2-hr	0.82	0.95	1.04	1.19	1.37	1.48	1.78	2.22	2.62	3.14	3.59	4.08
04	1-hr	0.65	0.76	0.83	0.95	1.09	1.18	1.42	1.77	2.09	2.50	2.86	3.25
04	30-min	0.52	0.60	0.66	0.75	0.86	0.93	1.12	1.39	1.64	1.97	2.25	2.56
04	15-min	0.37	0.44	0.49	0.56	0.63	0.68	0.81	1.02	1.20	1.44	1.64	1.87
04	10-min	0.30	0.35	0.39	0.45	0.50	0.55	0.66	0.83	0.98	1.17	1.34	1.52
04	5-min	0.17	0.19	0.21	0.24	0.28	0.30	0.36	0.45	0.53	0.64	0.73	0.83
05	10-day	2.13	2.62	2.96	3.48	4.00	4.35	5.15	6.21	6.97	8.04	8.90	9.92
05	5-day	1.75	2.10	2.37	2.75	3.15	3.42	4.12	4.96	5.67	6.76	7.65	8.78
05	72-hr	1.61	1.93	2.16	2.48	2.85	3.10	3.71	4.57	5.20	6.17	6.97	7.83
05	48-hr	1.51	1.77	1.95	2.26	2.57	2.82	3.40	4.16	4.77	5.66	6.40	7.16
05	24-hr	1.36	1.58	1.75	2.00	2.27	2.47	3.01	3.71	4.26	5.04	5.83	6.61
05	18-hr	1.25	1.47	1.62	1.84	2.09	2.27	2.77	3.41	3.92	4.63	5.37	6.08
05	12-hr	1.18	1.38	1.53	1.74	1.98	2.15	2.62	3.23	3.71	4.38	5.08	5.75
05	6-hr	1.00	1.18	1.32	1.49	1.70	1.85	2.26	2.78	3.20	3.78	4.38	4.96
05	3-hr	0.87	1.02	1.12	1.28	1.46	1.58	1.93	2.37	2.73	3.22	3.74	4.23
05	2-hr	0.79	0.93	1.03	1.17	1.34	1.46	1.78	2.19	2.52	2.97	3.44	3.90
05	1-hr	0.64	0.74	0.81	0.93	1.07	1.16	1.41	1.74	2.00	2.39	2.74	3.11
05	30-min	0.50	0.58	0.64	0.74	0.84	0.91	1.11	1.37	1.57	1.87	2.16	2.45
05	15-min	0.37	0.43	0.47	0.54	0.62	0.67	0.81	1.00	1.14	1.37	1.60	1.85
05	10-min	0.30	0.35	0.38	0.43	0.49	0.54	0.66	0.81	0.94	1.12	1.28	1.46
05	5-min	0.17	0.19	0.21	0.24	0.28	0.30	0.36	0.44	0.51	0.61	0.70	0.79
06	10-day	2.16	2.65	2.99	3.52	4.05	4.40	5.35	6.62	7.45	8.66	9.79	11.26
06	5-day	1.77	2.13	2.39	2.78	3.19	3.47	4.19	5.32	6.20	7.44	8.53	9.93
06	72-hr	1.63	1.95	2.16	2.50	2.88	3.13	3.81	4.85	5.68	6.84	7.76	8.92
06	48-hr	1.52	1.81	2.00	2.30	2.64	2.87	3.49	4.45	5.21	6.28	7.12	8.19
06	24-hr	1.42	1.66	1.84	2.10	2.38	2.59	3.11	3.93	4.65	5.57	6.46	7.45
06	18-hr	1.31	1.53	1.68	1.93	2.19	2.38	2.86	3.61	4.28	5.12	5.95	6.85
06	12-hr	1.24	1.44	1.57	1.82	2.07	2.25	2.71	3.39	3.97	4.84	5.62	6.48
06	6-hr	1.07	1.24	1.37	1.57	1.78	1.94	2.33	2.95	3.48	4.18	4.85	5.59
06	3-hr	0.91	1.07	1.18	1.34	1.52	1.66	1.99	2.51	2.98	3.56	4.14	4.77
06	2-hr	0.84	0.98	1.08	1.24	1.41	1.53	1.84	2.32	2.74	3.28	3.81	4.39
06	1-hr	0.67	0.79	0.87	0.99	1.12	1.21	1.46	1.85	2.19	2.62	3.04	3.50
06	30-min	0.53	0.61	0.68	0.78	0.88	0.96	1.15	1.46	1.72	2.06	2.39	2.75
06	15-min	0.38	0.45	0.49	0.57	0.64	0.70	0.84	1.06	1.26	1.52	1.75	2.01
06	10-min	0.31	0.36	0.40	0.46	0.52	0.57	0.68	0.87	1.02	1.22	1.42	1.64
06	5-min	0.17	0.20	0.22	0.25	0.29	0.31	0.37	0.47	0.56	0.67	0.78	0.89

Table 10. Median Time Distributions of Heavy Storm Rainfall at a Point

Cumulative storm time (percent)	*First-quartile* (1-hr)	*Second-quartile*	*Third-quartile* (24-hr)	*Fourth-quartile*
	Cumulative storm rainfall (percent) for given storm type			
5	16	3	3	2
10	33	8	6	5
15	43	12	9	8
20	52	16	12	10
25	60	22	15	13
30	66	29	19	16
35	71	39	23	19
40	75	51	27	22
45	79	62	32	25
50	82	70	38	28
55	84	76	45	32
60	86	81	57	35
65	88	85	70	39
70	90	88	79	45
75	92	91	85	51
80	94	93	89	59
85	96	95	92	72
90	97	97	95	84
95	98	98	97	92

WATERSHED DELINEATION

Shaw® Shaw Environmental, Inc.

Client: Clinton Landfill, Inc.
Project: Clinton Landfill No. 3
Proj.#: 128017
Calculated By: LJC Date: 9/14/07
Checked by: JPV Date: 9/17/07

TITLE: WATERSHED DELINEATION

Problem Statement

Delineate the watersheds for the interim conditions for the Clinton Landfill No. 3. Areas not flowing to Sediment Basin B will remain the same or will be smaller during the interim conditions.

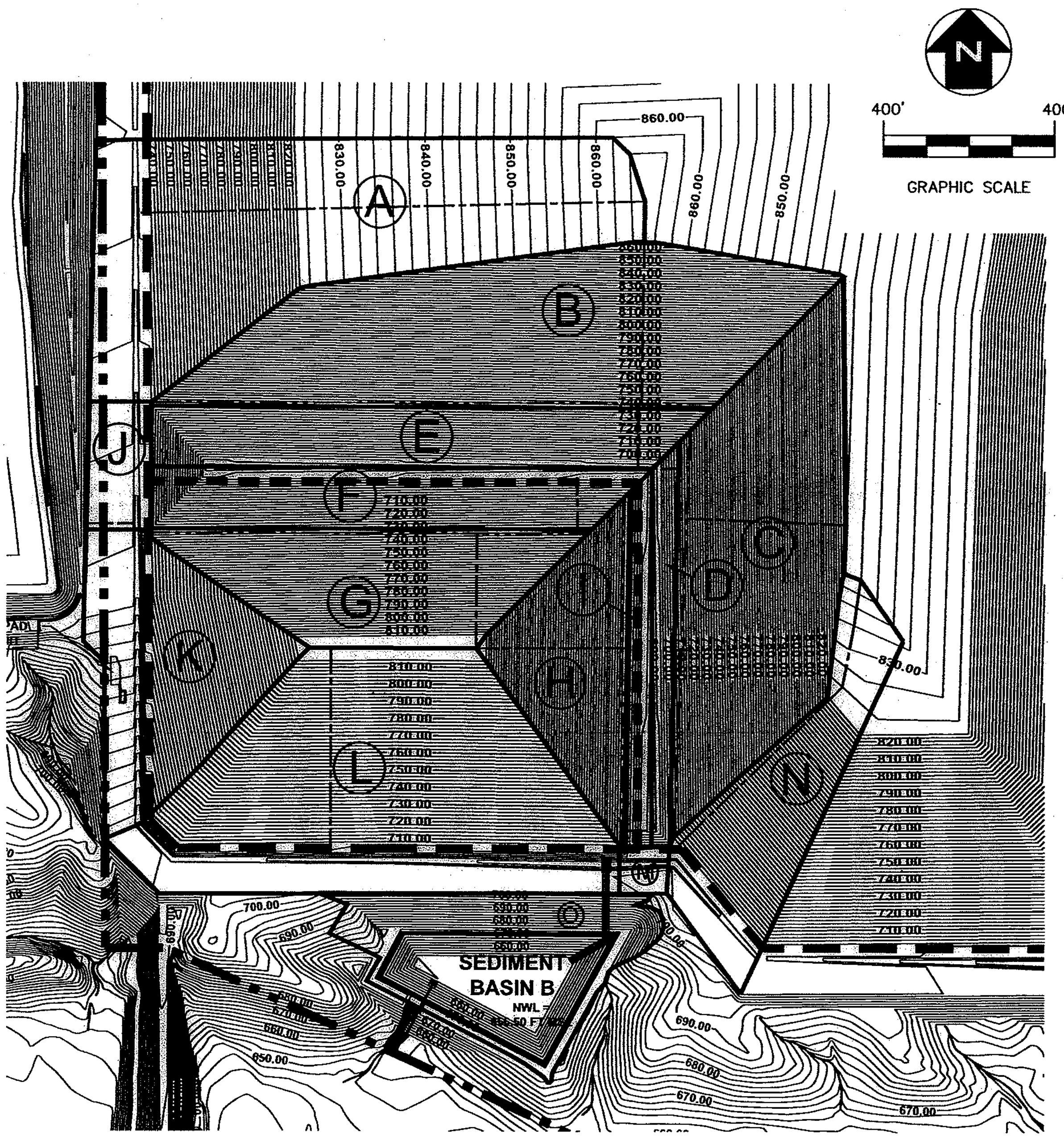
Given

The watersheds were reviewed using Figure M.1-1.

Results

Attached are delineations of the drainage areas of the interim conditions. The following table summarizes the acreage of the drainage areas. The longest flow lengths were also included in the table. This value is needed to calculate the travel time for a drop of water to travel through the subarea.

Proposed Interim Conditions				
Subarea	Area (sf)	Area (ac)	Area (mi2)	Overland Flow Length (ft)
Subareas Draining to Sediment Basin B				
A	481,370	11.05	0.0173	1,183
B	434,339	9.97	0.0156	374
C	364,977	8.38	0.0131	372
D	47,709	1.10	0.0017	40
E	176,531	4.05	0.0063	135
F	157,813	3.62	0.0057	121
G	201,813	4.63	0.0072	268
H	151,599	3.48	0.0054	357
I	48,143	1.11	0.0017	52
J	44,724	1.03	0.0016	100
K	210,996	4.84	0.0076	561
L	487,355	11.19	0.0175	482
M	12,138	0.28	0.0004	36
N	178,736	4.10	0.0064	783
O	99,975	2.30	0.0036	147



LEGEND

- APPROXIMATE FACILITY BOUNDARY
- APPROXIMATE WASTE BOUNDARY
- DRAINAGE AREA DIVIDE
- TIME OF CONCETRATION FLOW LENGTH
- TERRACE BERM

NOTES

1. FOR CLARITY, NOT ALL SITE FEATURES MAY BE SHOWN.

Shaw® Shaw Environmental, Inc.

CHEMICAL WASTE LANDFILL
CLINTON LANDFILL NO. 3

FIGURE M.1-1
WATERSHED DELINEATION
INTERIM CONDITIONS

APPROVED BY:	DAM	PROJ. NO.:	128017	DATE:	OCT 2007

DETERMINATION OF WEIGHTED CURVE NUMBER

Shaw®

Shaw® Shaw Environmental, Inc.

Client:	Clinton Landfill, Inc.		
Project:	Clinton Landfill No. 3		
Proj.#:	128017		
Calculated By:	LJC	Date:	9/18/07
Checked by:	JPV	Date:	9/19/07

TITLE: **DETERMINATION OF WEIGHTED CURVE NUMBER**

Objective

Determine the weighted curve number to be used for runoff calculations of the interim conditions.

Results

Based on curve number listed in TR-55 for dirt, a value of 90 is conservative for areas within the waste boundary that are not at final grade, this number is also conservative based on values used in the HELP model. Conservative curve numbers of 85 for the areas of the landfill at final grade (open space with good conditions) and 95 for areas made up of mostly the perimeter road (gravel) were used. Using these curve numbers in the HEC-HMS model will result in more runoff than is anticipated. The table below shows the curve number for each drainage area.

Subarea	Cover Type	Curve Number
A	Open Space, Good Conditions	85
B	Dirt	90
C	Dirt	90
D	Dirt	90
E	Dirt	90
F	Dirt	90
G	Dirt	90
H	Dirt	90
I	Dirt	90
J	Gravel	95
K	Open Space, Good Conditions	85
L	Open Space, Good Conditions	85
M	Gravel	95
N	Open Space Good Conditions	85
O	Open Space Good Conditions	85

Please note that interim final cover will be installed in subareas F, G, H, and I that will be capable of supporting vegetation. To be conservative, the cover type was assumed to be dirt.

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Technical
Release 55

June 1986

Urban Hydrology for Small Watersheds

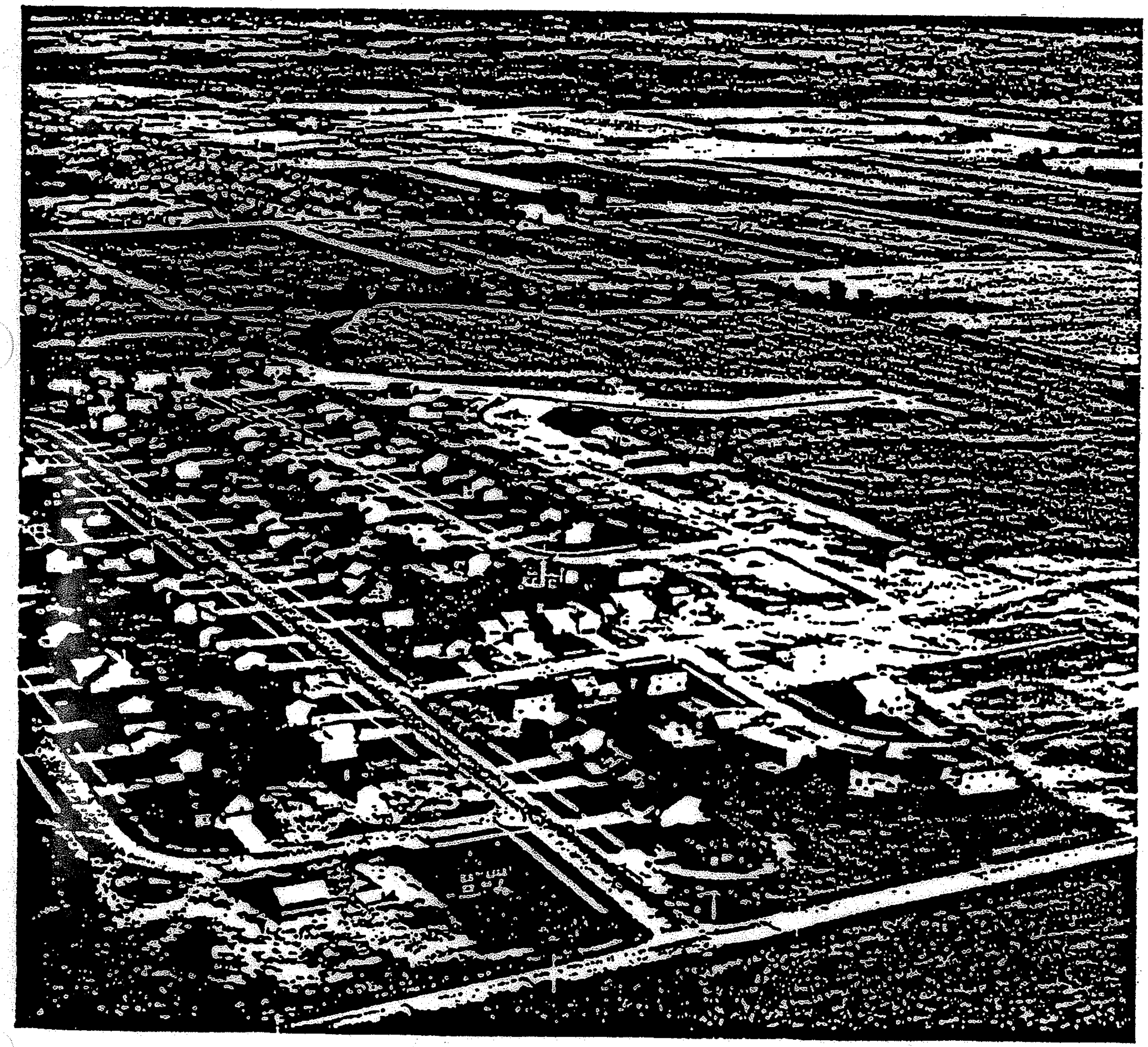

Table 2-2a.—Runoff curve numbers for urban areas[1]

Cover description		Curve numbers for hydrologic soil group—			
Cover type and hydrologic condition	Average percent impervious area[2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.)[3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only)[4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation)[5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

[1]Average runoff condition, and $I_a = 0.2S$.
[2]The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.
[3]CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.
[4]Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.
[5]Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4, based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

DETERMINATION OF SCS LAG TIME

Client: Clinton Landfill, Inc.

Project: Clinton Landfill No. 3

Proj.#: 128017

Shaw® Shaw Environmental, Inc.

Calculated By: LJC Date: 9/14/07

Checked by: JPV Date: 9/17/07

TITLE: DETERMINATION OF SCS LAG TIME

Problem Statement

Determine the SCS Lag Time for the final landform watersheds for the Clinton Landfill No. 3. The SCS Lag Time is equal to the lag time between the center of mass of rainfall excess and the peak of the unit hydrograph and is an input parameter for the HEC-HMS computer model to determine stormwater runoff.

Given

- The longest hydraulic flow paths for the proposed site conditions were determined from the proposed final landform drawings. (See attached figures in Appendix M.2.b - Watershed Delineation.)
- The time of concentration was calculated using the method outlined in Technical Release 55 (TR-55), Urban Hydrology for Small Watersheds, published by the Soil Conservation Service. (Refer to attached pages).
- The SCS lag time is equal to the time of concentration of the watershed multiplied by 0.6 (Refer to pages 6-8 of the ProHEC1 Plus manual).
- Roberson, J.A. and C.T. Crowe, Engineering Fluid Mechanics. John Wiley & Sons, Inc. (Refer to attached pages).

Assumptions

The following assumptions were made in the calculations:

- The Manning's n for sheet flow on the areas at final grade is assumed to be 0.15 (short grass prairie). This number is appropriate for the type of grass anticipated to grow on the landform after final closure. The Manning's n for sheet flow is assumed to be 0.011 for subareas J and M which encompass mainly the perimeter road. The Manning's n for sheet flow is assumed to be 0.011 for areas within the waste boundary which are not at final grade.
- An average slope for final conditions was calculated since the slope along the flow lengths vary.
- The Manning's n for the proposed and existing channels and the terrace ditches is assumed to be 0.023. This value is for an unlined, earth, straight, and uniform channel and is the lowest Manning's n probable. A higher Manning's number would be appropriate for a rockier or more vegetated channel. Since a higher Manning's number would result in longer time of concentrations and therefore a lower peak discharge, this assumption is conservative.

Shaw® Shaw Environmental, Inc.

Client:	Clinton Landfill, Inc.		
Project:	Clinton Landfill No. 3		
Proj.#:	128017		
Calculated By:	LJC	Date:	9/14/07
Checked by:	JPV	Date:	9/17/07

TITLE: DETERMINATION OF SCS LAG TIME

- ❑ The 2-year, 24-hour rain event provides the shortest time of concentrations and highest peak discharge. The 2-year, 24-hour rainfall is 3.02 inches. Refer to Calculation, "Determination of Rainfall Totals and Distributions".

- ❑ Terrace berms and downslopes ditches will be used to control erosion and minimize sedimentation during the final grading plan of the landfill as described in the Stormwater Management Plan. However, the calculation of the SCS Lag Time does not include these features, to maintain a more conservative design approach. The use of terrace berms and riprapped downslopes will typically increase the time of concentration allowing a lower peak flow.

Calculations

For each watershed the time of concentration, T_c, is the sum of the travel times, T_t, of various consecutive flow segments. There are three types of flow: sheet flow, shallow concentrated flow, and open channel flow.

Sheet Flow:
Sheet flow is flow over plane surfaces and is computed using the following equation.

$$T_t = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} s^{0.4}}$$

Where:

n	=	Manning roughness coefficient, unitless
L	=	Flow Length, ft
P_2	=	24-hour, 2-year rainfall = 3.02 inches
s	=	slope, ft/ft

After 300 feet, sheet flow becomes shallow concentrated flow.

Shallow Concentrated Flow:

The average velocity for shallow concentrated flow is calculated using figure 3-1: Average velocities for estimating travel time for shallow concentrated flow from Technical Release 55 (TR-55), Urban Hydrology for Small Watersheds.

Shaw® Shaw Environmental, Inc.

Client: Clinton Landfill, Inc.
Project: Clinton Landfill No. 3
Proj.#: 128017
Calculated By: LJC Date: 9/14/07
Checked by: JPV Date: 9/17/07

TITLE: DETERMINATION OF SCS LAG TIME

The travel time is then calculated using the following equation.

$$T_t = \frac{L}{3{,}600V}$$

Where:

L = Flow Length, ft
V = Average velocity, ft/sec
3,600 = Conversion factor from seconds to hours

Open Channel Flow:

Average velocity for open channels is calculated using the following equation.

$$V = \frac{1.49r^{2/3}s^{1/2}}{n}$$

Where:

V = Average velocity, ft/sec
r = hydraulic radius, ft and is equal to a/p_w
a = cross sectional flow area, ft^2
p_w = wetted perimeter, ft
n = Manning roughness coefficient
s = slope, ft/ft

The time of concentration for the watershed is then the summation of all travel times.

$$T_c = T_{t1} + T_{t2} + T_{t3} + \ldots.$$

To calculate the SCS lag time, the time of concentration is then multiplied by 0.6.

$$T_{lag} = 0.6\ T_c$$

There are no channel flows for the subareas in this case because it is calculated in the HEC-HMS model via the ditches and berms.

Results

For each watershed, all travel times, times of concentration, SCS lag times, as well as the necessary input parameters, are summarized in the attached spreadsheet.

CHEMICAL WASTE LANDFILL - CLINTON LANDFILL NO. 3
SCS LAG COMPUTATION - TR55 METHOD

2-year, 24-hour rainfall (inches) = 3.02
Manning's coefficient for channel flow (open flow) = 0.030

	SHEET FLOW				SHALLOW CONCENTRATED FLOW				CHANNEL FLOW*						RESULTS				
Subareas	Length (ft)	Cover	n	Slope (ft/ft)	Length (ft)	Cover	Slope (ft/ft)	Velocity (ft/sec)	Length (ft)	Slope (ft/ft)	Depth (ft)	A (ft^2)	pw (ft)	Velocity (ft/sec)	Tt - Sheet (min)	Tt - Shallow Conc. (min)	Tt-Channel (min)	Tc (min)	SCS Lag Time (min)
Subareas Draining to Sediment Basin B																			
A	300.0	Short Grass Prairie	0.150	0.0500	883.0	Unpaved	0.1286	5.79	0.0	0.0	0.0	0.0	0.0	0.0	16.8356	2.5435	0.0000	19.3791	11.63
B	300.0	Bare Soil	0.011	0.1667	74.0	Unpaved	0.1667	6.59	0.0	0.0	0.0	0.0	0.0	0.0	1.2861	0.1872	0.0000	1.4733	0.88
C	300.0	Bare Soil	0.011	0.3333	72.0	Unpaved	0.3333	9.32	0.0	0.0	0.0	0.0	0.0	0.0	0.9748	0.1288	0.0000	1.1036	0.66
D	40.0	Bare Soil	0.011	0.3500	0.0	Unpaved	0.0000	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.1907	0.0000	0.0000	0.1907	0.11
E	135.0	Bare Soil	0.011	0.3259	0.0	Unpaved	0.0000	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.5193	0.0000	0.0000	0.5193	0.31
F	121.0	Bare Soil	0.011	0.3223	0.0	Unpaved	0.0000	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.4778	0.0000	0.0000	0.4778	0.29
G	268.0	Bare Soil	0.011	0.2948	0.0	Unpaved	0.0000	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.9355	0.0000	0.0000	0.9355	0.56
H	300.0	Bare Soil	0.011	0.3067	57	Unpaved	0.3333	9.31	0.0	0.0	0.0	0.0	0.0	0.0	1.0078	0.1020	0.0000	1.1098	0.67
I	52.0	Bare Soil	0.011	0.2692	0	Unpaved	0.0000	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.2613	0.0000	0.0000	0.2613	0.16
J	100.0	Gravel	0.011	0.0040	0	Unpaved	0.0000	0.00	0.0	0.0	0.0	0.0	0.0	0.0	2.3743	0.0000	0.0000	2.3743	1.42
K	300.0	Short Grass Prairie	0.150	0.1833	261	Unpaved	0.2069	7.34	0.0	0.0	0.0	0.0	0.0	0.0	10.0127	0.5927	0.0000	10.6054	6.36
L	300.0	Short Grass Prairie	0.150	0.2300	182	Unpaved	0.2418	7.93	0.0	0.0	0.0	0.0	0.0	0.0	9.1438	0.3823	0.0000	9.5261	5.72
M	36.0	Gravel	0.011	0.0833	0	Unpaved	0.0000	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.3113	0.0000	0.0000	0.3113	0.19
N	300.0	Short Grass Prairie	0.150	0.0533	483	Unpaved	0.0000	0.00	0.0	0.0	0.0	0.0	0.0	0.0	16.4106	0.0000	0.0000	16.4106	9.85
O	147.0	Short Grass Prairie	0.15	0.2040	0.0	Unpaved	0.0000	n/a	0.0	0.0	0.0	0.0	0.0	0.0	5.4215	0.0000	0.0000	5.4215	3.25

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Technical
Release 55

June 1986

Urban Hydrology for Small Watersheds

Chapter 3: Time of concentration and travel time

Travel time (T_t) is the time it takes water to travel from one location to another in a watershed. T_t is a component of time of concentration (T_c), which is the time for runoff to travel from the hydraulically most distant point of the watershed to a point of interest within the watershed. T_c is computed by summing all the travel times for consecutive components of the drainage conveyance system.

T_c influences the shape and peak of the runoff hydrograph. Urbanization usually decreases T_c, thereby increasing the peak discharge. But T_c can be increased as a result of (a) ponding behind small or inadequate drainage systems, including storm drain inlets and road culverts, or (b) reduction of land slope through grading.

Factors affecting time of concentration and travel time

Surface roughness

One of the most significant effects of urban development on flow velocity is less retardance to flow. That is, undeveloped areas with very slow and shallow overland flow through vegetation become modified by urban development: the flow is then delivered to streets, gutters, and storm sewers that transport runoff downstream more rapidly. Travel time through the watershed is generally decreased.

Channel shape and flow patterns

In small non-urban watersheds, much of the travel time results from overland flow in upstream areas. Typically, urbanization reduces overland flow lengths by conveying storm runoff into a channel as soon as possible. Since channel designs have efficient hydraulic characteristics, runoff flow velocity increases and travel time decreases.

Slope

Slopes may be increased or decreased by urbanization, depending on the extent of site grading or the extent to which storm sewers and street ditches are used in the design of the water management system. Slope will tend to increase when channels are straightened and decrease when overland flow is directed through storm sewers, street gutters, and diversions.

Computation of travel time and time of concentration

Water moves through a watershed as sheet flow, shallow concentrated flow, open channel flow, or some combination of these. The type that occurs is a function of the conveyance system and is best determined by field inspection.

Travel time (T_t) is the ratio of flow length to flow velocity:

$$T_t = \frac{L}{3600\ V} \qquad \text{[Eq. 3-1]}$$

where

T_t = travel time (hr),
L = flow length (ft),
V = average velocity (ft/s), and
3600 = conversion factor from seconds to hours.

Time of concentration (T_c) is the sum of T_t values for the various consecutive flow segments:

$$T_c = T_{t_1} + T_{t_2} + \dots T_{t_m} \qquad \text{[Eq. 3-2]}$$

where

T_c = time of concentration (hr) and
m = number of flow segments.

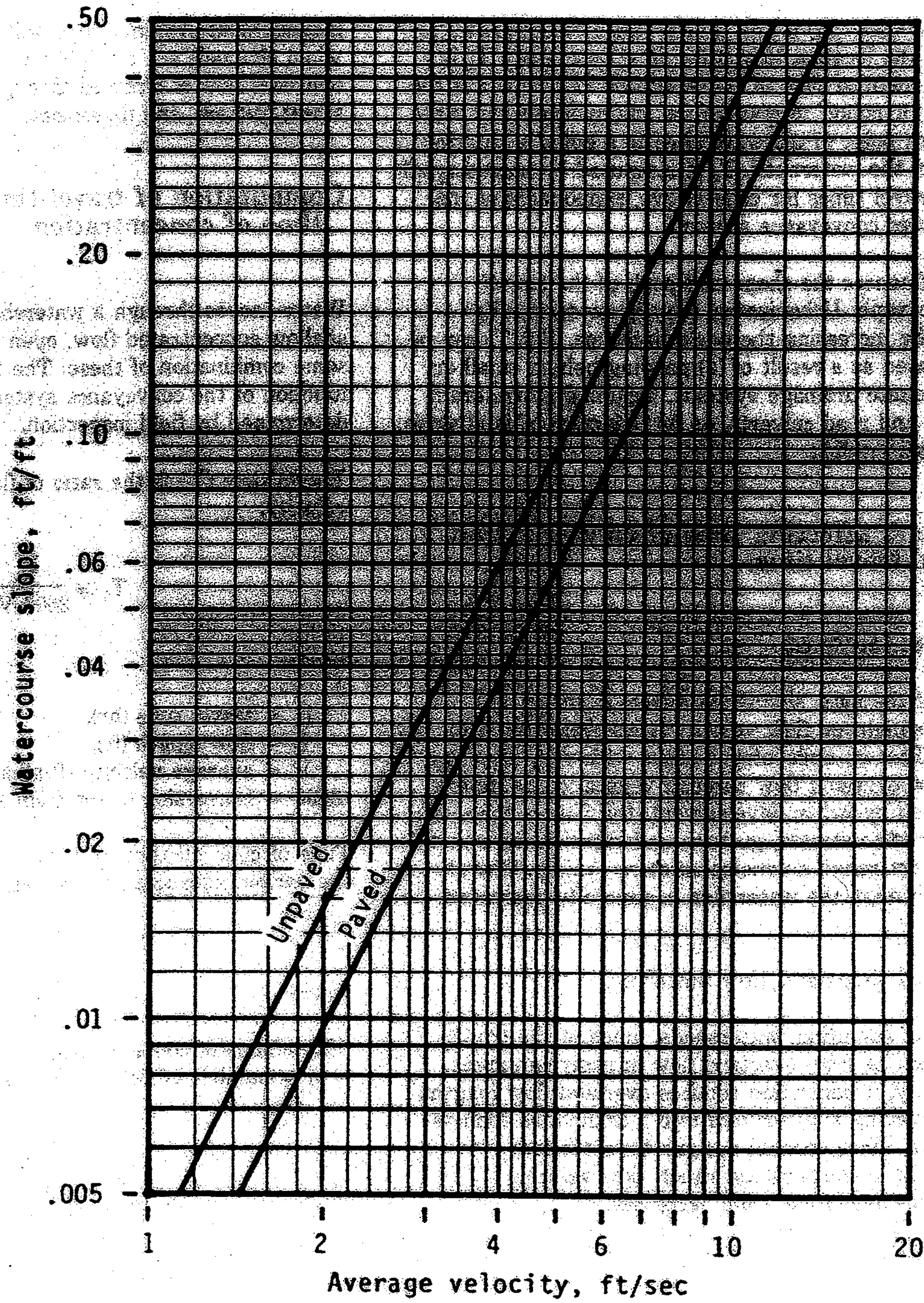


Figure 3-1.—Average velocities for estimating travel time for shallow concentrated flow.

Sheet flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges, and rocks; and erosion and transportation of sediment. These n values are for very shallow flow depths of about 0.1 foot or so. Table 3-1 gives Manning's n values for sheet flow for various surface conditions.

For sheet flow of less than 300 feet, use Manning's kinematic solution (Overton and Meadows 1976) to compute T_t:

$$T_t = \frac{0.007\,(nL)^{0.8}}{(P_2)^{0.5}\, s^{0.4}} \qquad \text{[Eq. 3-3]}$$

Table 3-1.—Roughness coefficients (Manning's n) for sheet flow

Surface description	n[1]
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover ≤20%	0.06
Residue cover >20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses[2]	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods:[3]	
Light underbrush	0.40
Dense underbrush	0.80

[1]The n values are a composite of information compiled by Engman (1986).
[2]Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
[3]When selecting n, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

where

T_t = travel time (hr),
n = Manning's roughness coefficient (table 3-1),
L = flow length (ft),
P_2 = 2-year, 24-hour rainfall (in), and
s = slope of hydraulic grade line (land slope, ft/ft).

This simplified form of the Manning's kinematic solution is based on the following: (1) shallow steady uniform flow, (2) constant intensity of rainfall excess (that part of a rain available for runoff), (3) rainfall duration of 24 hours, and (4) minor effect of infiltration on travel time. Rainfall depth can be obtained from appendix B.

Shallow concentrated flow

After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from figure 3-1, in which average velocity is a function of watercourse slope and type of channel. For slopes less than 0.005 ft/ft, use equations given in appendix F for figure 3-1. Tillage can affect the direction of shallow concentrated flow. Flow may not always be directly down the watershed slope if tillage runs across the slope.

After determining average velocity in figure 3-1, use equation 3-1 to estimate travel time for the shallow concentrated flow segment.

Open channels

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheets. Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bank-full elevation.

Manning's equation is

$$V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n} \qquad \text{[Eq. 3-4]}$$

where

- V = average velocity (ft/s),
- r = hydraulic radius (ft) and is equal to a/p_w,
- a = cross sectional flow area (ft^2),
- p_w = wetted perimeter (ft),
- s = slope of the hydraulic grade line (channel slope, ft/ft), and
- n = Manning's roughness coefficient for open channel flow.

Manning's n values for open channel flow can be obtained from standard textbooks such as Chow (1959) or Linsley et al. (1982). After average velocity is computed using equation 3-4, T_t for the channel segment can be estimated using equation 3-1.

Reservoirs or lakes

Sometimes it is necessary to estimate the velocity of flow through a reservoir or lake at the outlet of a watershed. This travel time is normally very small and can be assumed as zero.

Limitations

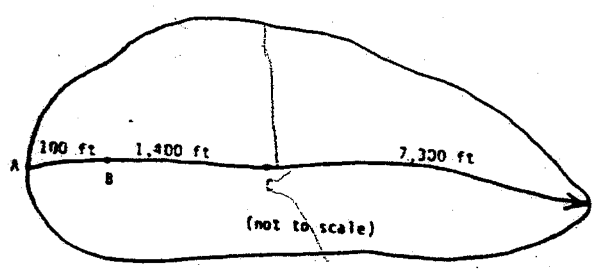
- Manning's kinematic solution should not be used for sheet flow longer than 300 feet. Equation 3-3 was developed for use with the four standard rainfall intensity-duration relationships.
- In watersheds with storm sewers, carefully identify the appropriate hydraulic flow path to estimate T_c. Storm sewers generally handle only a small portion of a large event. The rest of the peak flow travels by streets, lawns, and so on, to the outlet. Consult a standard hydraulics textbook to determine average velocity in pipes for either pressure or nonpressure flow.
- The minimum T_c used in TR-55 is 0.1 hour.
- A culvert or bridge can act as a reservoir outlet if there is significant storage behind it. The procedures in TR-55 can be used to determine the peak flow upstream of the culvert. Detailed storage routing procedures should be used to determine the outflow through the culvert.

Example 3-1

The sketch below shows a watershed in Dyer County, northwestern Tennessee. The problem is to compute T_c at the outlet of the watershed (point D). The 2-year 24-hour rainfall depth is 3.6 inches. All three types of flow occur from the hydraulically most distant point (A) to the point of interest (D). To compute T_c, first determine T_t for each segment from the following information:

Segment AB: Sheet flow; dense grass; slope (s) = 0.01 ft/ft; and length (L) = 100 ft.
Segment BC: Shallow concentrated flow; unpaved; s = 0.01 ft/ft; and L = 1400 ft.
Segment CD: Channel flow; Manning's n = .05; flow area (a) = 27 ft^2; wetted perimeter (p_w) = 28.2 ft; s = 0.005 ft/ft; and L = 7300 ft.

See figure 3-2 for the computations made on worksheet 3.



Appendix F: Equations for figures and exhibits

This appendix presents the equations used in procedure applications to generate figures and exhibits in TR-55.

Figure 2-1 (runoff equation):

$$Q = \frac{\left[P - 0.2\left(\frac{1000}{CN} - 10\right)\right]^2}{P + 0.8\left(\frac{1000}{CN} - 10\right)}$$

where

Q = runoff (in),
P = rainfall (in), and
CN = runoff curve number.

Figure 2-3 (composite CN with connected impervious area):

$$CN_c = CN_p + (P_{imp}/100)(98 - CN_p)$$

where

CN_c = composite runoff curve number,
CN_p = pervious runoff curve number, and
P_{imp} = percent imperviousness.

Figure 2-4 (composite CN with unconnected impervious areas and total impervious area less than 30%):

$$CN_c = CN_p + (P_{imp}/100)(98 - CN_p)(1 - 0.5R)$$

where R = ratio of unconnected impervious area to total impervious area.

Figure 3-1 (average velocities for estimating travel time for shallow concentrated flow):

Unpaved $V = 16.1345\,(s)^{0.5}$
Paved $V = 20.3282\,(s)^{0.5}$

where

V = average velocity (ft/s), and
s = slope of hydraulic grade line (watercourse slope, ft/ft).

These two equations are based on the solution of Manning's equation (Eq. 3-4) with different assumptions for n (Manning's roughness coefficient) and r (hydraulic radius, ft). For unpaved areas, n is 0.05 and r is 0.4; for paved areas, n is 0.025 and r is 0.2.

Exhibit 4 (unit peak discharges for SCS type I, IA, II, and III distributions):

$$\log(q_u) = C_0 + C_1 \log(T_c) + C_2 [\log(T_c)]^2$$

where

q_u = unit peak discharge (csm/in),
T_c = time of concentration (hr) (minimum, 0.1; maximum, 10.0), and
C_0, C_1, C_2 = coefficients from table F-1.

Figure 6-1 (approximate detention basin routing through single- and multiple-stage structures for 24-hour rainfalls of the indicated type):

$$V_s/V_r = C_0 + C_1 (q_o/q_i) + C_2 (q_o/q_i)^2 + C_3 (q_o/q_i)^3$$

where

V_s/V_r = ratio of storage volume (V_s) to runoff volume (V_r),
q_o/q_i = ratio of peak outflow discharge (q_o) to peak inflow discharge (q_i), and
C_0, C_1, C_2, C_3 = coefficients from table F-2.

THE DODSON PROFESSIONAL HEC-1 SYSTEM

An Enhanced Version of the Standard Corps of Engineers' Watershed Modeling Computer Program

ProHEC1 *Plus*

Program Documentation

DODSON
& ASSOCIATES, INC.
Hydrologists and Civil Engineers

The unit hydrograph is interpolated for the specified computation interval and computed peak flow rate from the dimensionless unitgraph shown in Figure 6.4. The dimensionless unitgraph ratios are listed in Table 6.4.

Since the program computation interval is used in the computation of T_{PEAK} and Q_{PEAK} for the unit hydrograph, changing the computation interval will affect the computed unit hydrograph. The SCS Dimensionless hydrograph was originally formulated by assuming that $\Delta t = 0.2 \times T_{PEAK}$. To minimize errors, the computation interval Δt used in HEC-1 should be less than or equal to $0.29 \times T_{PEAK}$. The SCS also assumed that $\boxed{T_{LAG} = 0.6 \times T_C}$ and that $1.7 \times T_{PEAK} = \Delta t + T_C$ where T_C is the time of concentration of the watershed. Using these relationships, along with equation 6.2, it is evident that the computation interval Δt should be less than or equal to $0.29 \times T_{LAG}$.

FIGURE 6.4 SCS Dimensionless Unitgraph Method

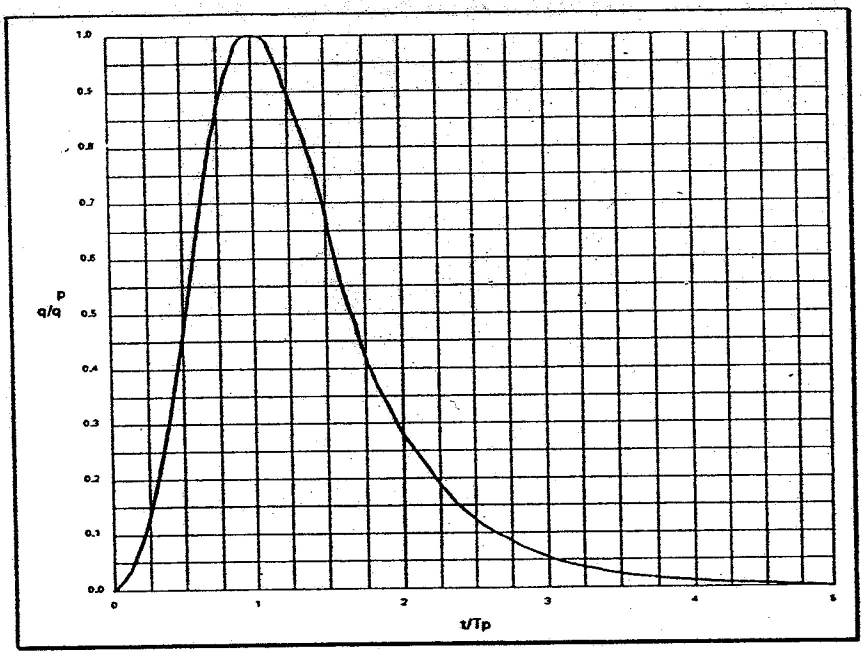


TABLE 6.4 SCS Dimensionless Unitgraph Discharge Ratios

Time Ratios (t/Tp)	Discharge Ratios (q/qp)	Time Ratios (t/Tp)	Discharge Ratios (q/qp	Time Ratios (t/Tp)	Discharge Ratios (q/qp)
0.0	0.000	1.1	0.990	2.4	0.147
0.1	0.030	1.2	0.930	2.6	0.107
0.2	0.100	1.3	0.860	2.8	0.077
0.3	0.190	1.4	0.780	3.0	0.055
0.4	0.310	1.5	0.680	3.2	0.040
0.5	0.470	1.6	0.560	3.4	0.029
0.6	0.660	1.7	0.460	3.6	0.021
0.7	0.820	1.8	0.390	3.8	0.015
0.8	0.930	1.9	0.330	4.0	0.011
0.9	0.990	2.0	0.280	4.5	0.005
1.0	1.000	2.2	0.207	5.0	0.000

Clark Unit Hydrograph Computation

The HEC-1 UC record and an optional set of UA records are used to enter the input data necessary to compute a unit hydrograph using the Clark method. The Clark method requires three

ENGINEERING FLUID MECHANICS

SIXTH EDITION

JOHN A. ROBERSON
CLAYTON T. CROWE

When we insert this expression for C into Eq. (10.42), we obtain a common form of the discharge equation for uniform flow in open channels for SI units:

$$Q = \frac{1.0}{n} A R_h^{2/3} S_0^{1/2} \tag{10.44}$$

In Eq. (10.44), n is a resistance coefficient called Manning's n, which has different values for different types of boundary roughness. Table 10.3 gives n for various types of boundary surfaces. The major limitation of this approach is that the viscous or relative roughness effects are not present in the design formula. Hence, application outside the range of normal-sized channels carrying water is not recommended.

Manning Equation—Traditional System of Units

It can be shown that, in converting from SI to the traditional system of units, one must apply a factor equal to 1.49 if the same value of n is used in the two

[illegible]

Lined Canals	n
Cement plaster	0.011
Untreated gunite	0.016
Wood, planed	0.012
Wood, unplaned	0.013
Concrete, troweled	0.012
Concrete, wood forms, unfinished	0.015
Rubble in cement	0.020
Asphalt, smooth	0.013
Asphalt, rough	0.016
Corrugated metal	0.024
Unlined Canals	
Earth, straight and uniform	0.023
Earth, winding and weedy banks	0.035
Cut in rock, straight and uniform	0.030
Cut in rock, jagged and irregular	0.045
Natural Channels	
Gravel beds, straight	0.025
Gravel beds plus large boulders	0.040
Earth, straight, with some grass	0.026
Earth, winding, no vegetation	0.030
Earth, winding, weedy banks	0.050
Earth, very weedy and overgrown	0.080

ORIFICE DISCHARGE CALCULATIONS

Shaw®

Shaw® Shaw Environmental, Inc.

Client:	Clinton Landfill, Inc.		
Project:	Clinton Landfill No. 3		
Proj. #:	128017		
Calculated By:	LJC	Date:	10/5/07
Checked By:	JPV	Date:	10/5/07

TITLE: ORIFICE DISCHARGE CALCULATIONS

Problem Statement

Develop a discharge versus water elevation for the proposed spillway of Sediment Basin B. This chart will then be an input parameter for the HEC-HMS model used to determine stormwater runoff.

Given

References

- "Hydrology and Floodplain Analysis" by Philip B. Bedient of Rice University and Wayne C. Huber of University of Florida

Outlet Structure Design Parameters

Sediment Basin B

The primary outlet structure consists of a perforated standpipe with perforations beginning at elevation 656.5 (Normal Water Level). The standpipe is connected to a 24" culvert which is fitted with a valve. The valve will remain closed until impounded water has cleared to excessive sediment. The sedimentation basin will be modeled with the valve closed, therefore discharges up to the spillway were zero. The secondary outlet structure is a trapezoidal spillway located at elevation is 670.5, has a length of 30' and side slopes of 5 horizontal to 1 vertical.

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Client: Clinton Landfill, Inc.

Project: Clinton Landfill No. 3

Proj. #: 128017

Calculated By: LJC Date: 10/5/07

Checked By: JPV Date: 10/5/07

TITLE: ORIFICE DISCHARGE CALCULATIONS

Assumptions

Equation 1 is used to calculate flow through the 4' x 4' drop box, which acts like a weir.

Equation 1

$$Q = CL(h - h_0)^{3/2}$$

Where:

Q = Flow, cfs
C = weir coefficient = 3.3 (unitless)
h = water elevation, feet
h_0 = weir elevation, feet
L = weir length perpendicular to flow

Spillways act as broadcrest weirs. For spillway calculations, the average weir length perpendicular to flow is used. The average weir length for trapezoidal spillways is equal to the average between the bottom spillway width and the top width of the water surface. For a spillway with 5V:1H sideslopes, the top of water width is equal to the base width of the spillway plus 10 times the height of the water elevation above the invert elevation.

$$L_{ave} = L + 5(h - h_0)$$

Shaw® Shaw Environmental, Inc.

Client: Clinton Landfill, Inc.
Project: Clinton Landfill No. 3
Proj. #: 128017
Calculated By: LJC **Date:** 10/5/07
Checked By: JPV **Date:** 10/5/07

TITLE: ORIFICE DISCHARGE CALCULATIONS

Rewriting Equation No. 1 for a spillway with 5H:1V sideslopes yields equation no. 2.

Equation No. 2

$$Q = C[L + 5(h - h_0)](h - h_0)^{3/2}$$

Where:

Q = Flow, cfs
C = weir coefficient = 3.3 (unitless)
h = water elevation, feet
h_0 = weir elevation, feet
L = base width of the spillway

Calculations

The attached spreadsheet summarizes the discharge over the spillway for Sediment Basin B.

Results

The discharges for various elevations were entered into the HEC-HMS model. Results of the model indicate that the spillway is sufficiently sized to covey water from the detention basins with at least 1 foot of freeboard during the 100-year, 24-hour storm event. Refer to Calculation Sheet "Hydrologic Model Analyses," and HEC-HMS output files for a summary of peak discharge rates and basin elevations. Also refer to Section 4, "Stormwater Management Plan" for a detailed discussion.

SPILLWAY DISCHARGE CALCULATION FOR DETENTION BASIN OUTLET STRUCTURES
CLINTON LANDFILL NO. 3
SEDIMENT BASIN B

Spillway Bottom Width (ft):	30.0
Spillway Sideslopes:	5H:1V
Spillway Elevation (ft):	670.5
Spillway (Broadcrest Weir) Coefficient:	3.1

Elevations (ft)	Spillway Weir Flow[3] (cfs)
670.50	0.000
671.00	35.621
671.50	108.500
672.00	213.565
672.50	350.725
673.00	520.788
673.50	724.863

Notes:
[3]Weir flow equation for Spillway:
Q=(weir coefficient)*(spillway base width + 5*(elev-spillway elev)*(elev-spillway elev)^1.5

Hydrology and Floodplain Analysis

Philip B. Bedient
RICE UNIVERSITY
Wayne C. Huber
UNIVERSITY OF FLORIDA

ADDISON-WESLEY PUBLISHING COMPANY
Reading, Massachusetts ▪ Menlo Park, California ▪ New York
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where

Q_i = inflow (cfs),
Q = outflow (cfs),
$\mathcal{V}$ = storage (ft^3),
t = time (s).

The inflow $Q_i(t)$ may consist of upstream flows or rainfall or both and is assumed to be known. A second equation is thus needed to solve for the two unknowns, $Q(t)$ and $\mathcal{V}(t)$; Muskingum and detention basin routing were shown for this purpose in Chapter 4. An additional alternative is to use the relationship

$$Q = K\mathcal{V}^b, \tag{6.13}$$

where K and b are power function parameters that may be fit by regression techniques or through physical relationships. For example, outflow by a weir or orifice or by Manning's equation lends itself naturally to a power function, especially if depth $h(t)$ is used as the dependent variable instead of $\mathcal{V}(t)$ by the relationship

$$d\mathcal{V}/dt = A(h)\frac{dh}{dt}, \tag{6.14}$$

where

A = surface area and is a function of depth h.

Then a weir outflow can be represented as

$$Q = C_w L_w (h - h_0)^{1.5}, \tag{6.15}$$

where

L_w = weir length (perpendicular to flow),
h_o = weir crest elevation,
C_w = weir coefficient.

The weir coefficient is dimensional and depends on several factors, especially the weir geometry (Daugherty et al., 1985). Common values for horizontal weirs perpendicular to the flow direction are $C_w = 3.33$ ft$^{0.5}$/s for U.S. customary units and $C_w = 1.84$ m$^{0.5}$/s for metric units.

An orifice would be included as

$$Q = C_d A_o \sqrt{2g(h - h_o)}, \tag{6.16}$$

where

C_d = discharge coefficient,
A_o = area of orifice,
h_o = elevation of orifice centerline.

Submerged culverts often behave as orifices with discharge coefficients ranging from 0.62 for a sharp-edged entrance to nearly 1.0 for a well-rounded entrance (Daugherty et al., 1985). Apart from their universal presence near highways, culverts are widely used as outlets from detention ponds in urban areas.

Finally, Manning's equation can be used as the second relationship between storage and outflow. For a wide rectangular channel (as for overland flow) the hydraulic radius is equal to the depth, and Manning's equation has the form

$$Q = W(k_m/n)(h - DS)^{5/3}S^{1/2}, \tag{6.17}$$

where

W = width of (overland) flow,
n = Manning's roughness,
DS = depression storage (depth),
S = slope.

(The constant k_m was discussed in conjunction with Eq. 6.4.) The relationship (6.17) can be coupled with the continuity equation for generation of overland flow, as shown in Example 6.8.

EXAMPLE 6.8

NONLINEAR RESERVOIR MODEL FOR OVERLAND FLOW

Derive a method for generation of overland flow from rainfall by coupling the continuity equation, Eq. (6.12), with Manning's equation, Eq. (6.17).

SOLUTION

Let inflow to the "reservoir" equal the product of rainfall excess i_e and catchment area A. Using U.S. customary units, Manning's equation can be substituted into the continuity equation, yielding

$$i_e A - W(1.49/n)(h - DS)^{5/3}S^{1/2} = A\frac{dh}{dt},$$

in which the surface area A is assumed to be constant. Dividing by the area gives

$$i_e + \text{WCON}(h - DS)^{5/3} = \frac{dh}{dt}, \tag{6.18}$$

where

$$\text{WCON} \equiv -\frac{1.49\, WS^{1/2}}{An} \tag{6.19}$$

2. Select the desired cross-sectional shape of your channel in the Channel Type section of the dialog.
3. Enter the appropriate geometric attributes for that channel shape in English units.
4. Select the Enter Depth option if you want to calculate the flow. Select the Enter Flow option if you want to calculate depth. Then enter the depth/flow accordingly.
5. Select the Calculate button in the lower portion of the dialog. You will notice that flow/depth is displayed as well as the other channel properties. Figure 4 is an example of computing flow for a trapezoidal channel.
6. Select OK or Cancel to exit the dialog.

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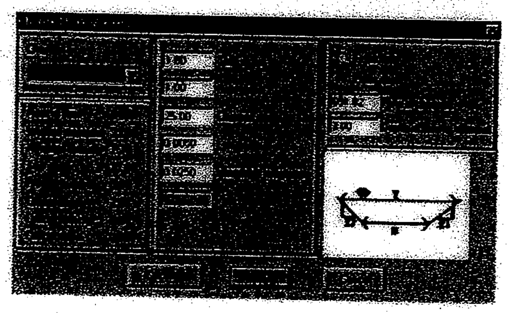
Figure 4 Channel Calculator dialog box for a trapezoidal channel



Weir Calculator

The Weir Calculator can compute head or flow over a weir. If you enter the head, it will compute the flow. If you enter the flow, it will compute the head necessary to obtain that flow. If a hydrograph has been computed from one of the models, the peak flow from that hydrograph will automatically be entered in the flow field. You may change this value, of course.

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Weir Equation

The Weir Calculator uses the standard equation for computing flow over a weir.

$$Q = C_w L h^{3/2}$$

Where:

Q - flow in cfs
Cw - weir coefficient
L - length of the weir in feet
h - head in feet

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Supported Weir Types

There are six predefined weir types included in this calculator. Upon selecting any of these weirs, the appropriate weir coefficient will automatically be entered in the Cw field. There is also a user-defined weir option. For this option you can specify your own weir coefficient. For all of the options you will have to enter the weir length.

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Weir Types	Cw
Broad-crested	3.1
Cipolletti	3.367
V-notch 90 degrees	2.5
V-notch 60 degrees	1.443
V-notch 45 degrees	1.035
V-notch 22.5 degrees	0.497
User-defined weir	User specified

Using the Weir Calculator

1. Select Weirs from the Calculators menu in the Tree module.
2. Select the desired weir in the Weir Type section of the dialog box.
3. Enter the Weir Length (and Weir Coefficient, if applicable) in the appropriate field.
4. Select the Calculate Flow option if you want to calculate the flow, or the Calculate Head option if you want to calculate the head. Then enter the Head/Weir flow accordingly.
5. Select the Calculate button. You will notice that the calculated head/flow appears. Your dialog should look similar to Figure 5.
6. Select OK or Cancel to exit the dialog.

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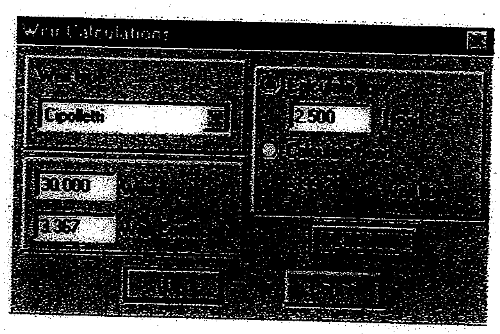
Figure 5 Weir Calculator dialog box



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HEC-HMS MODEL ANALYSIS

Shaw® Shaw Environmental, Inc.

Client:	Clinton Landfill, Inc.
Project:	Clinton Landfill No. 3
Proj. #:	128017
Calculated By:	LJC — Date: 9/19/07
Checked By:	JPV — Date: 9/20/07

TITLE: HYDROLOGIC MODELING ANALYSES

Problem Statement

Determine the stormwater runoff rates and quantities for the interim conditions for the proposed Chemical Waste Unit at Clinton Landfill No. 3. Additionally, determine if the proposed stormwater detention basins are adequately sized to retain the runoff from the 25-year, 24-hour storm event and safely discharge the 100-year, 24-hour storm event through the spillway.

Given

The stormwater runoff was calculated using the HEC-HMS computer program. This program was developed and distributed by the U.S. Army Corps of Engineers. The program can be downloaded from the following website: http://www.hec.usace.army.mil/software/hec-hms/hechms-hechms.html

Assumptions

Various parameters, such as rainfall, drainage area, curve number, SCS lag time, and discharge and storage volume of the stormwater detention basins are entered into the program. Calculations to determine these parameters are described in previous portions of this Appendix. Additional information is also available in Section 4 of this application. The following tables summarize the basin design parameters entered into the model. (See attached tables)

The following parameters were entered into HEC-HMS to determine if the basins are properly sized to handle the 100-year, 1-hour and 24-hour storm events and determine the peak discharge rates.

Shaw® Shaw Environmental, Inc.

Client: Clinton Landfill, Inc.
Project: Clinton Landfill No. 3
Proj. #: 128017
Calculated By: LJC Date: 9/19/07
Checked By: JPV Date: 9/20/07

TITLE: HYDROLOGIC MODELING ANALYSES

Design Input Parameters for Sediment Basin B		
Elevation (feet MSL)	**Area at Elevation (acres)**	**Total Outflow (cfs)**
656.50	1.17	0.000
658.00	1.32	0.000
660.00	1.48	0.000
662.00	1.64	0.000
664.00	1.81	0.000
666.00	1.99	0.000
668.00	2.17	0.000
670.00	2.36	0.000
670.50	N/A	0.000
671.00	N/A	35.621
672.00	2.56	213.650
673.00	2.66	520.788

Calculations

The interim conditions were analyzed for the 1-hour and 24-hour storm events for the 100-year frequency and the 24-hour duration for the 25-year frequency.

Results

Results of the HEC-HMS computer models are summarized in the following tables. The computer output files are also attached.

Shaw® Shaw Environmental, Inc.

Client: Clinton Landfill, Inc.
Project: Clinton Landfill No. 3
Proj. #: 128017
Calculated By: LJC Date: 9/19/07
Checked By: JPV Date: 9/20/07

TITLE: **HYDROLOGIC MODELING ANALYSES**

HEC-HMS Results Discharge for the 100-year storm events (cfs)		
Location	**Duration**	
Scenario	**1-hour**	**24-hour**
Sediment Basin B		
Subarea A	30.1	7.6
Subarea B	49.1	7.2
Subarea C	41.3	6.0
Subarea D	5.4	0.8
Subarea E	19.8	2.9
Subarea F	18.0	2.6
Subarea G	22.7	3.3
Subarea H	17.0	2.5
Subarea I	5.4	0.8
Subarea J	6.4	0.8
Subarea K	15.7	3.3
Subarea L	37.0	7.7
Subarea M	1.6	0.2
Subarea N	11.8	2.8
Subarea O	8.3	1.6

Shaw® Shaw Environmental, Inc.

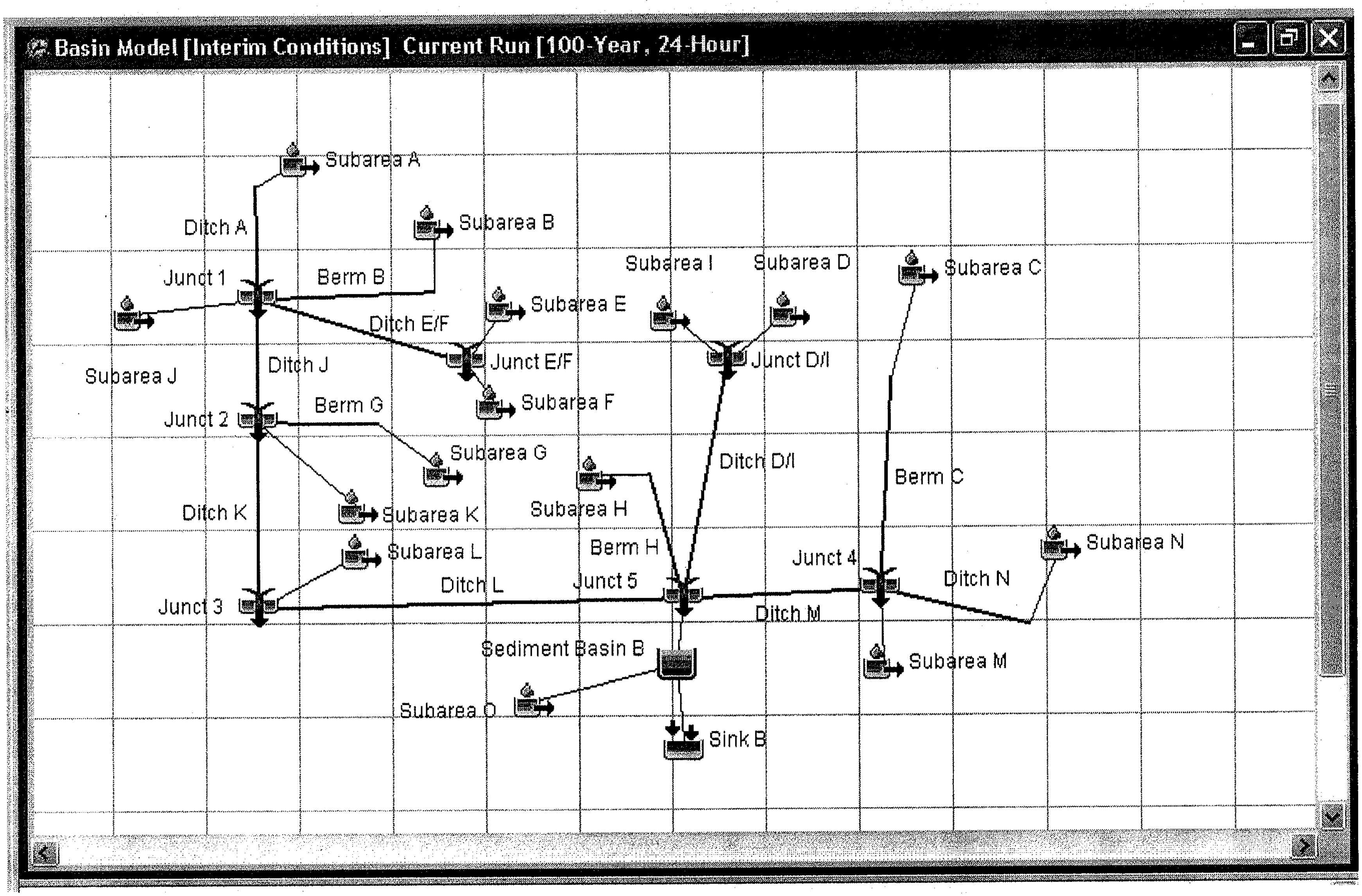
Client: Clinton Landfill, Inc.
Project: Clinton Landfill No. 3
Proj. #: 128017
Calculated By: LJC Date: 9/19/07
Checked By: JPV Date: 9/20/07

TITLE: HYDROLOGIC MODELING ANALYSES

Stormwater Detention Basin Design Hydrologic Results									
Location	***100-yr Maximum Inflow (cfs)***		***100-yr Maximum Outflow (cfs)***		***100-yr Maximum Elevation (ft)***		***Top of Basin (ft)***	**25-yr Maximum Elevation (ft)**	**Spillway Elevation (ft)**
	1-hour	24-hour	1-hour	24-hour	1-hour	24-hour		24-hour	
Sediment Basin B	184.5	49.6	0.0	17.7	662.9	670.7	674.00	669.8	670.5

Conclusion

Based on the HEC-HMS output results, the basins are properly sized to convey the 100-year, 24-hour storm event and retain the 25-year, 24-hour storm event.


Basin Model [Interim Conditions] Current Run [100-Year, 24-Hour]
Subarea A
Ditch A
Subarea B
Junct 1
Berm B
Subarea I
Subarea D
Subarea C
Subarea E
Ditch E/F
Subarea J
Ditch J
Junct E/F
Junct D/I
Subarea F
Junct 2
Berm G
Subarea G
Ditch D/I
Berm C
Ditch K
Subarea K
Subarea H
Subarea L
Berm H
Subarea N
Junct 4
Ditch N
Ditch L
Junct 5
Junct 3
Ditch M
Sediment Basin B
Subarea M
Subarea O
Sink B

Project: Interim - Closed Valve Simulation Run: 100-Year, 1-Hour

Start of Run: 01Jan2007, 00:00
End of Run: 03Jan2007, 00:00
Compute Time: 05Oct2007, 14:04:00

Basin Model: Interim Conditions
Meteorologic Model: 100-Year, 1-Hour
Control Specifications: 1 Hour

Volume Units: IN

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Berm B	0.0156	37.4	01Jan2007, 00:18	1.74
Berm C	0.0131	31.2	01Jan2007, 00:15	1.74
Berm G	0.0072	17.4	01Jan2007, 00:18	1.75
Berm H	0.0054	12.9	01Jan2007, 00:18	1.74
Ditch A	0.0173	22.4	01Jan2007, 00:33	1.36
Ditch D/I	0.0034	8.1	01Jan2007, 00:21	1.77
Ditch E/F	0.0120	28.6	01Jan2007, 00:18	1.73
Ditch J	0.0465	78.4	01Jan2007, 00:21	1.62
Ditch K	0.0613	104.7	01Jan2007, 00:21	1.60
Ditch L	0.0788	130.5	01Jan2007, 00:24	1.55
Ditch M	0.0199	35.3	01Jan2007, 00:18	1.63
Ditch N	0.0064	8.7	01Jan2007, 00:30	1.36
Junct 1	0.0465	79.0	01Jan2007, 00:21	1.61
Junct 2	0.0613	106.2	01Jan2007, 00:21	1.60
Junct 3	0.0788	132.3	01Jan2007, 00:21	1.55
Junct 4	0.0199	35.6	01Jan2007, 00:18	1.62
Junct 5	0.1075	179.4	01Jan2007, 00:24	1.58
Junct D/I	0.0034	8.4	01Jan2007, 00:15	1.74
Junct E/F	0.0120	29.5	01Jan2007, 00:15	1.74
Sediment Basin B	0.1111	0.0	01Jan2007, 00:00	0.00
Sink B	0.1111	0.0	01Jan2007, 00:00	0.00
Subarea A	0.0173	22.6	01Jan2007, 00:30	1.36
Subarea B	0.0156	38.4	01Jan2007, 00:15	1.74
Subarea C	0.0131	32.2	01Jan2007, 00:15	1.74
Subarea D	0.0017	4.2	01Jan2007, 00:15	1.74

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subarea E	0.0063	15.5	01Jan2007, 00:15	1.74
Subarea F	0.0057	14.0	01Jan2007, 00:15	1.74
Subarea G	0.0072	17.7	01Jan2007, 00:15	1.74
Subarea H	0.0054	13.3	01Jan2007, 00:15	1.74
Subarea I	0.0017	4.2	01Jan2007, 00:15	1.74
Subarea J	0.0016	5.1	01Jan2007, 00:12	2.19
Subarea K	0.0076	11.6	01Jan2007, 00:21	1.36
Subarea L	0.0175	27.5	01Jan2007, 00:21	1.36
Subarea M	0.0004	1.3	01Jan2007, 00:12	2.19
Subarea N	0.0064	8.8	01Jan2007, 00:27	1.36
Subarea O	0.0036	6.2	01Jan2007, 00:18	1.36

Project :	Interim - Closed Valve	Simulation Run :	100-Year, 1-Hour	Reservoir:	Sediment Basin B

Start of Run :	01Jan2007, 00:00	Basin Model :	Interim Conditions
End of Run :	03Jan2007, 00:00	Meteorologic Model :	100-Year, 1-Hour
Compute Time :	05Oct2007, 14:04:00	Control Specifications :	1 Hour

Volume Units : IN

Computed Results

Peak Inflow :	184.5 (CFS)	Date/Time of Peak Inflow :	01Jan2007, 00:24
Peak Outflow :	0.0 (CFS)	Date/Time of Peak Outflow :	01Jan2007, 00:00
Total Inflow :	1.57 (IN)	Peak Storage :	9.3 (AC-FT)
Total Outflow :	0.00 (IN)	Peak Elevation :	662.9 (FT)

Project: Interim - Closed Valve Simulation Run: 100-Year, 24-Hour

Start of Run: 01Jan2007, 00:00 Basin Model: Interim Conditions
End of Run: 05Jan2007, 00:00 Meteorologic Model: 100-Year, 24-Hour
Compute Time: 05Oct2007, 15:35:37 Control Specifications: 24 Hour

Volume Units: IN

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Berm B	0.0156	7.2	01Jan2007, 15:20	5.69
Berm C	0.0131	6.0	01Jan2007, 15:20	5.69
Berm G	0.0072	3.3	01Jan2007, 15:20	5.69
Berm H	0.0054	2.5	01Jan2007, 15:20	5.68
Ditch A	0.0173	7.5	01Jan2007, 15:20	5.12
Ditch D/I	0.0034	1.6	01Jan2007, 15:20	5.68
Ditch E/F	0.0120	5.5	01Jan2007, 15:20	5.68
Ditch J	0.0465	20.9	01Jan2007, 15:20	5.50
Ditch K	0.0613	27.5	01Jan2007, 15:20	5.47
Ditch L	0.0788	35.0	01Jan2007, 15:20	5.39
Ditch M	0.0199	9.0	01Jan2007, 15:20	5.52
Ditch N	0.0064	2.8	01Jan2007, 15:20	5.12
Junct 1	0.0465	21.0	01Jan2007, 15:20	5.49
Junct 2	0.0613	27.6	01Jan2007, 15:20	5.47
Junct 3	0.0788	35.2	01Jan2007, 15:20	5.39
Junct 4	0.0199	9.0	01Jan2007, 15:20	5.52
Junct 5	0.1075	48.1	01Jan2007, 15:20	5.44
Junct D/I	0.0034	1.6	01Jan2007, 15:20	5.69
Junct E/F	0.0120	5.5	01Jan2007, 15:20	5.69
Sediment Basin B	0.1111	17.7	01Jan2007, 18:40	1.23
Sink B	0.1111	17.7	01Jan2007, 18:40	1.23
Subarea A	0.0173	7.6	01Jan2007, 15:20	5.12
Subarea B	0.0156	7.2	01Jan2007, 15:20	5.69
Subarea C	0.0131	6.0	01Jan2007, 15:20	5.69
Subarea D	0.0017	0.8	01Jan2007, 15:20	5.69

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subarea E	0.0063	2.9	01Jan2007, 15:20	5.69
Subarea F	0.0057	2.6	01Jan2007, 15:20	5.69
Subarea G	0.0072	3.3	01Jan2007, 15:20	5.69
Subarea H	0.0054	2.5	01Jan2007, 15:20	5.69
Subarea I	0.0017	0.8	01Jan2007, 15:20	5.69
Subarea J	0.0016	0.8	01Jan2007, 15:20	6.27
Subarea K	0.0076	3.3	01Jan2007, 15:20	5.12
Subarea L	0.0175	7.7	01Jan2007, 15:20	5.12
Subarea M	0.0004	0.2	01Jan2007, 15:20	6.27
Subarea N	0.0064	2.8	01Jan2007, 15:20	5.12
Subarea O	0.0036	1.6	01Jan2007, 15:20	5.12

Project :	Interim - Closed Valve	Simulation Run :	100-Year, 24-Hour	Reservoir:	Sediment Basin B

Start of Run :	01Jan2007, 00:00	Basin Model :	Interim Conditions
End of Run :	05Jan2007, 00:00	Meteorologic Model :	100-Year, 24-Hour
Compute Time :	05Oct2007, 15:35:37	Control Specifications :	24 Hour

Volume Units : IN

Computed Results

Peak Inflow :	**49.6 (CFS)**	**Date/Time of Peak Inflow :**	**01Jan2007, 15:20**
Peak Outflow :	**17.7 (CFS)**	**Date/Time of Peak Outflow :**	**01Jan2007, 18:40**
Total Inflow :	**5.43 (IN)**	**Peak Storage :**	**25.5 (AC-FT)**
Total Outflow :	**1.23 (IN)**	**Peak Elevation :**	**670.7 (FT)**

Project: Interim - Closed Valve Simulation Run: 25-Year, 24-Hour

Start of Run: 01Jan2007, 00:00 Basin Model: Interim Conditions
End of Run: 05Jan2007, 00:00 Meteorologic Model: 25-Year, 24-Hour
Compute Time: 05Oct2007, 14:55:35 Control Specifications: 24 Hour

Volume Units: IN

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Berm B	0.0156	5.3	01Jan2007, 15:20	4.15
Berm C	0.0131	4.5	01Jan2007, 15:20	4.15
Berm G	0.0072	2.5	01Jan2007, 15:20	4.15
Berm H	0.0054	1.8	01Jan2007, 15:20	4.15
Ditch A	0.0173	5.5	01Jan2007, 15:20	3.63
Ditch D/I	0.0034	1.2	01Jan2007, 15:20	4.14
Ditch E/F	0.0120	4.1	01Jan2007, 15:20	4.14
Ditch J	0.0465	15.5	01Jan2007, 15:20	3.97
Ditch K	0.0613	20.3	01Jan2007, 15:20	3.95
Ditch L	0.0788	25.8	01Jan2007, 15:20	3.88
Ditch M	0.0199	6.7	01Jan2007, 15:20	3.99
Ditch N	0.0064	2.0	01Jan2007, 15:20	3.63
Junct 1	0.0465	15.5	01Jan2007, 15:20	3.97
Junct 2	0.0613	20.3	01Jan2007, 15:20	3.95
Junct 3	0.0788	25.9	01Jan2007, 15:20	3.88
Junct 4	0.0199	6.7	01Jan2007, 15:20	3.99
Junct 5	0.1075	35.4	01Jan2007, 15:20	3.92
Junct D/I	0.0034	1.2	01Jan2007, 15:20	4.15
Junct E/F	0.0120	4.1	01Jan2007, 15:20	4.15
Sediment Basin B	0.1111	0.0	01Jan2007, 00:00	0.00
Sink B	0.1111	0.0	01Jan2007, 00:00	0.00
Subarea A	0.0173	5.5	01Jan2007, 15:20	3.63
Subarea B	0.0156	5.3	01Jan2007, 15:20	4.15
Subarea C	0.0131	4.5	01Jan2007, 15:20	4.15
Subarea D	0.0017	0.6	01Jan2007, 15:20	4.15

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subarea E	0.0063	2.2	01Jan2007, 15:20	4.15
Subarea F	0.0057	2.0	01Jan2007, 15:20	4.15
Subarea G	0.0072	2.5	01Jan2007, 15:20	4.15
Subarea H	0.0054	1.9	01Jan2007, 15:20	4.15
Subarea I	0.0017	0.6	01Jan2007, 15:20	4.15
Subarea J	0.0016	0.6	01Jan2007, 15:20	4.70
Subarea K	0.0076	2.4	01Jan2007, 15:20	3.63
Subarea L	0.0175	5.6	01Jan2007, 15:20	3.63
Subarea M	0.0004	0.1	01Jan2007, 15:20	4.70
Subarea N	0.0064	2.0	01Jan2007, 15:20	3.63
Subarea O	0.0036	1.1	01Jan2007, 15:20	3.63

Project :	Interim - Closed Valve	Simulation Run :	25-Year, 24-Hour	Reservoir:	Sediment Basin B

Start of Run :	01Jan2007, 00:00	Basin Model :	Interim Conditions
End of Run :	05Jan2007, 00:00	Meteorologic Model :	25-Year, 24-Hour
Compute Time :	05Oct2007, 14:55:35	Control Specifications :	24 Hour

Volume Units : IN

Computed Results

Peak Inflow :	36.6 (CFS)	Date/Time of Peak Inflow :	01Jan2007, 15:20
Peak Outflow :	0.0 (CFS)	Date/Time of Peak Outflow :	01Jan2007, 00:00
Total Inflow :	3.91 (IN)	Peak Storage :	23.2 (AC-FT)
Total Outflow :	0.00 (IN)	Peak Elevation :	669.8 (FT)

DITCH SIZE

Shaw® Shaw Environmental, Inc.

Client: Clinton Landfill, Inc.

Project: Clinton Landfil No. 3

Proj. #: 128017

Calculated By: LJC Date: 9/21/07

Checked By: JPV Date: 9/24/07

TITLE: **DITCH SIZE**

Problem Statement

Determine the size of all perimeter ditches to adequately handle the peak flow from the 100-year, 1-hour storm event.

Given

The following table summarizes the peak flows from the 100-year, 1-hour storm event that were determined using HEC-HMS computer program and the drainage areas shown on Drawing No. D16. (Note the SCS Lag Time was conservatively calculated without the terraces and downslopes).

Design Parameters for Ditches					
Ditch/Berm	*Q_{peak} (cfs)*	*Channel Slope (ft/ft)*	*Bottom Width (ft)*	*Sideslopes*	*Channel Depth (ft)*
A	30.0	0.0084	6	2H:1V	3
B	48.6	0.0045	0	3H:1V & 2H:1V	3
C	40.7	0.0171	0	3H:1V & 2H:1V	3
D/I	10.5	0.0050	7	3H:1V	3
E/F	37.2	0.0050	7	3H:1V	3
G	22.4	0.0050	0	3H:1V & 2H:1V	3
H	16.8	0.0024	0	3H:1V & 2H:1V	3
J	102.0	0.0084	6	2H:1V	3
K	137.3	0.0395	6	2H:1V	3
L	172.7	0.0044	6	2H:1V	3
M	46.0	0.0068	6	2H:1V	6.7
N	11.7	0.0113	6	2H:1V	1.5

Shaw® Shaw Environmental, Inc.

Client: Clinton Landfill, Inc.
Project: Clinton Landfil No. 3
Proj. #: 128017
Calculated By: LJC Date: 9/21/07
Checked By: JPV Date: 9/24/07

TITLE: DITCH SIZE

Assumptions

- ❑ The Manning's roughness coefficient was assumed to be 0.030 for grass lined channels and 0.023 for unlined channels.

Calculations

Calculations were performed using the computer program, Flowmaster, by Haestad Methods. The program uses Manning's equation.

$$V = (1.49/n)R^{2/3}S^{1/2}$$

where:

V = mean velocity, ft/sec
n = Manning's roughness coefficient
R = hydraulic radius, ft
S = slope, ft/ft

Manning's n, peak flow, sideslope, and channel slope were entered into the program and the program solves for depth and velocity. As stated above, Manning's n was varied to determine the critical depth and critical velocity. The Flowmaster output files, which includes all input parameters, are attached.

Results

The Flowmaster results are summarized in the following table. Based on the results, all ditches are adequately sized to handle the peak 100-year, 1-hour storm event and velocities are lower than the recommended values to minimize scour and erosion. Additional erosion protection methods, such as: turf reinforced mats, rock check dams, straw bales will be used for any ditches with velocities over 5 ft/sec.

Shaw® Shaw Environmental, Inc.

Client: Clinton Landfill, Inc.
Project: Clinton Landfill No. 3
Proj. #: 128017
Calculated By: LJC Date: 9/21/07
Checked By: JPV Date: 9/24/07

TITLE: DITCH SIZE

Ditch/Berm Summary Table				
Ditch/Berm	*Q_{peak} (cfs)*	*Channel Depth (feet)*	*Flow Depth (ft)*	*Velocity (ft/sec)*
A	30.0	3	0.99	3.78
B	48.6	3	2.13	4.29
C	40.7	3	1.55	6.77
D/I	10.5	3	0.57	2.11
E/F	37.2	3	1.14	3.11
G	22.4	3	1.56	3.68
H	16.8	3	1.61	2.60
J	102.0	3	1.92	5.40
K	137.3	3	1.49	10.23
L	172.7	3	2.95	4.92
M	46.0	6.7	1.33	3.99
N	11.7	1.5	0.53	3.09

Ditch A
Worksheet for Trapezoidal Channel

Project Description	
Project File	t:\projects\2007\128017 - clinton tcsa\design\stormwater\interim\ditches.fm2
Worksheet	Ditch A
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.008400	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	6.00	ft
Discharge	30.00	cfs

Results		
Depth	0.99	ft
Flow Area	7.94	ft^2
Wetted Perimeter	10.44	ft
Top Width	9.97	ft
Critical Depth	0.83	ft
Critical Slope	0.015722	ft/ft
Velocity	3.78	ft/s
Velocity Head	0.22	ft
Specific Energy	1.22	ft
Froude Number	0.75	
Flow is subcritical.		

Berm B
Worksheet for Triangular Channel

Project Description	
Project File	t:\projects\2007\128017 - clinton tcsa\design\stormwater\interim\ditches.fm2
Worksheet	Berm B
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.023	
Channel Slope	0.004500	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	48.60	cfs

Results		
Depth	2.13	ft
Flow Area	11.32	ft²
Wetted Perimeter	11.49	ft
Top Width	10.64	ft
Critical Depth	1.88	ft
Critical Slope	0.008716	ft/ft
Velocity	4.29	ft/s
Velocity Head	0.29	ft
Specific Energy	2.41	ft
Froude Number	0.73	
Flow is subcritical.		

Berm C
Worksheet for Triangular Channel

Project Description	
Project File	t:\projects\2007\128017 - clinton tcsa\design\stormwater\interim\ditches.fm2
Worksheet	Berm C
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.023	
Channel Slope	0.017100	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	40.70	cfs

Results		
Depth	1.55	ft
Flow Area	6.01	ft^2
Wetted Perimeter	8.37	ft
Top Width	7.75	ft
Critical Depth	1.75	ft
Critical Slope	0.008924	ft/ft
Velocity	6.77	ft/s
Velocity Head	0.71	ft
Specific Energy	2.26	ft
Froude Number	1.36	
Flow is supercritical.		

Ditch D/I

Worksheet for Trapezoidal Channel

Project Description	
Project File	t:\projects\2007\128017 - clinton tcsa\design\stormwater\interim\ditches.fm2
Worksheet	Ditch D/I
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.005000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	7.00	ft
Discharge	10.50	cfs

Results		
Depth	0.57	ft
Flow Area	4.97	ft^2
Wetted Perimeter	10.61	ft
Top Width	10.42	ft
Critical Depth	0.39	ft
Critical Slope	0.019127	ft/ft
Velocity	2.11	ft/s
Velocity Head	0.07	ft
Specific Energy	0.64	ft
Froude Number	0.54	
Flow is subcritical.		

Ditch E/F
Worksheet for Trapezoidal Channel

Project Description	
Project File	t:\projects\2007\128017 - clinton tcsa\design\stormwater\interim\ditches.fm2
Worksheet	Ditch E/F
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.005000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	7.00	ft
Discharge	37.20	cfs

Results		
Depth	1.14	ft
Flow Area	11.94	ft^2
Wetted Perimeter	14.24	ft
Top Width	13.87	ft
Critical Depth	0.84	ft
Critical Slope	0.015471	ft/ft
Velocity	3.11	ft/s
Velocity Head	0.15	ft
Specific Energy	1.30	ft
Froude Number	0.59	
Flow is subcritical.		

Berm G

Worksheet for Triangular Channel

Project Description	
Project File	t:\projects\2007\128017 - clinton tcsa\design\stormwater\interim\ditches.fm2
Worksheet	Berm G
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.023	
Channel Slope	0.005000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	22.40	cfs

Results		
Depth	1.56	ft
Flow Area	6.09	ft^2
Wetted Perimeter	8.42	ft
Top Width	7.80	ft
Critical Depth	1.38	ft
Critical Slope	0.009664	ft/ft
Velocity	3.68	ft/s
Velocity Head	0.21	ft
Specific Energy	1.77	ft
Froude Number	0.73	
Flow is subcritical.		

Berm H
Worksheet for Triangular Channel

Project Description	
Project File	t:\projects\2007\128017 - clinton tcsa\design\stormwater\interim\ditches.fm2
Worksheet	Berm H
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.023	
Channel Slope	0.002400	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	2.000000	H : V
Discharge	16.80	cfs

Results		
Depth	1.61	ft
Flow Area	6.46	ft^2
Wetted Perimeter	8.68	ft
Top Width	8.04	ft
Critical Depth	1.23	ft
Critical Slope	0.010042	ft/ft
Velocity	2.60	ft/s
Velocity Head	0.11	ft
Specific Energy	1.71	ft
Froude Number	0.51	
Flow is subcritical.		

Ditch J
Worksheet for Trapezoidal Channel

Project Description	
Project File	t:\projects\2007\128017 - clinton tcsa\design\stormwater\interim\ditches.fm2
Worksheet	Ditch J
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.008400	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	6.00	ft
Discharge	102.00	cfs

Results		
Depth	1.92	ft
Flow Area	18.91	ft^2
Wetted Perimeter	14.59	ft
Top Width	13.68	ft
Critical Depth	1.71	ft
Critical Slope	0.013196	ft/ft
Velocity	5.40	ft/s
Velocity Head	0.45	ft
Specific Energy	2.37	ft
Froude Number	0.81	
Flow is subcritical.		

Ditch K
Worksheet for Trapezoidal Channel

Project Description	
Project File	t:\projects\2007\128017 - clinton tcsa\design\stormwater\interim\ditches.fm2
Worksheet	Ditch K
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.039500	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	6.00	ft
Discharge	137.30	cfs

Results		
Depth	1.49	ft
Flow Area	13.43	ft²
Wetted Perimeter	12.68	ft
Top Width	11.98	ft
Critical Depth	2.01	ft
Critical Slope	0.012682	ft/ft
Velocity	10.23	ft/s
Velocity Head	1.63	ft
Specific Energy	3.12	ft
Froude Number	1.70	
Flow is supercritical.		

Ditch L

Worksheet for Trapezoidal Channel

Project Description	
Project File	t:\projects\2007\128017 - clinton tcsa\design\stormwater\interim\ditches.fm2
Worksheet	Ditch L
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.004400	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	6.00	ft
Discharge	172.70	cfs

Results		
Depth	2.95	ft
Flow Area	35.13	ft²
Wetted Perimeter	19.20	ft
Top Width	17.81	ft
Critical Depth	2.28	ft
Critical Slope	0.012306	ft/ft
Velocity	4.92	ft/s
Velocity Head	0.38	ft
Specific Energy	3.33	ft
Froude Number	0.62	
Flow is subcritical.		

Ditch M
Worksheet for Trapezoidal Channel

Project Description	
Project File	t:\projects\2007\128017 - clinton tcsa\design\stormwater\interim\ditches.fm2
Worksheet	Ditch M
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.006800	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	6.00	ft
Discharge	46.00	cfs

Results		
Depth	1.33	ft
Flow Area	11.53	ft²
Wetted Perimeter	11.95	ft
Top Width	11.33	ft
Critical Depth	1.08	ft
Critical Slope	0.014750	ft/ft
Velocity	3.99	ft/s
Velocity Head	0.25	ft
Specific Energy	1.58	ft
Froude Number	0.70	
Flow is subcritical.		

Ditch N
Worksheet for Trapezoidal Channel

Project Description	
Project File	t:\projects\2007\128017 - clinton tcsa\design\stormwater\interim\ditches.fm2
Worksheet	Ditch N
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.011300 ft/ft	
Left Side Slope	2.000000 H : V	
Right Side Slope	2.000000 H : V	
Bottom Width	6.00	ft
Discharge	11.70	cfs

Results		
Depth	0.53	ft
Flow Area	3.78	ft^2
Wetted Perimeter	8.39	ft
Top Width	8.14	ft
Critical Depth	0.46	ft
Critical Slope	0.018315 ft/ft	
Velocity	3.09	ft/s
Velocity Head	0.15	ft
Specific Energy	0.68	ft
Froude Number	0.80	
Flow is subcritical.		

APPENDIX J.2

STORMWATER CALCULATIONS - CLOSED CONDITIONS

Shaw®

DETERMINATION OF RAINFALL TOTALS AND DISTRIBUTIONS

Shaw®

Client:	Clinton Landfill, Inc.		
Project:	Clinton Landfill No. 3		
Proj.#:	128017		
Calculated By:	LJC	Date:	9/14/07
Checked by:	JPV	Date:	9/17/07

Shaw® Shaw Environmental, Inc.

TITLE: DETERMINATION OF RAINFALL TOTALS AND DISTRIBUTION

Problem Statement

Determine the total rainfall intensity for the 2-year, 25-year and 100-year frequencies. The rainfall intensity for the 25-year and 100-year frequencies is used in the HEC-HMS model to determine rainfall runoff and the 2-year frequency is used in the calculations to determine SCS Lag Time.

Given

Rainfall data was obtained from Bulletin 71 (see attached reference).

Assumptions

Based on the information provided in Bulletin 71, it was assumed that the rainfall distribution of the 1-hour storm for all storm frequencies corresponds to the first-quartile distribution pattern, i.e the heaviest rainfall occurs in the first quarter of the storm event. For the 24-hour storms, a third-quartile distribution pattern is more appropriate.

Results

As shown on Figure 1 of Bulletin 71, DeWitt County is located in the Central Climatic Section. From Table 1 of Bulletin 71, the following conservative total rainfalls were used in the hydrologic analyses.

Recurrence Interval	24-Hour (inches)	1-Hour (inches)
2-Year	3.02	1.42
25-Year	5.32	2.50
100-Year	6.92	3.25

The table below summarizes the cumulative percent rainfall for the first- and third-quartile distributions shown in Table 1 of Bulletin 71. The total rainfall and percentages are entered into the HEC-HMS model and the program multiplies the percentages by the total rainfall to develop a rainfall hydrograph for each storm frequency.

Shaw® Shaw Environmental, Inc.

Client: Clinton Landfill, Inc.
Project: Clinton Landfill No. 3
Proj.#: 128017
Calculated By: LJC Date: 9/14/07
Checked by: JPV Date: 9/17/07

TITLE: DETERMINATION OF RAINFALL TOTALS AND DISTRIBUTION

	Cumulative Storm Rainfall (percent)	
Cumulative Storm Time (percent)	First Quartile (1-hour Storm)	Third Quartile (24-hour Storm)
5	16	3
10	33	6
15	43	9
20	52	12
25	60	15
30	66	19
35	71	23
40	75	27
45	79	32
50	82	38
55	84	45
60	86	57
65	88	70
70	90	79
75	92	85
80	94	89
85	96	92
90	97	95
95	98	97

1st Quartile Rainfall Distribution

Storm Event	25-year, 1-hour storm event for Clinton Landfill No. 3
Enter Rainfall Depth (in)	2.50
Storm Length (hrs.)	1

Cumulative Storm Rainfall (%)	First Quartile (%)	Time	Cumulative Precipitation (in)
0	0	0:00	0.00
5	16	0:03	0.40
10	33	0:06	0.83
15	43	0:09	1.08
20	52	0:12	1.30
25	60	0:15	1.50
30	66	0:18	1.65
35	71	0:21	1.78
40	75	0:24	1.88
45	79	0:27	1.98
50	82	0:30	2.05
55	84	0:33	2.10
60	86	0:36	2.15
65	88	0:39	2.20
70	90	0:42	2.25
75	92	0:45	2.30
80	94	0:48	2.35
85	96	0:51	2.40
90	97	0:54	2.43
95	98	0:57	2.45
100	100	1:00	2.50

Time Interval (min)	3

3rd Quartile Rainfall Distribution

Storm Event	25-year, 24-hour storm event for Clinton Landfill No. 3
Enter Rainfall Depth (in)	5.32
Storm Length (hrs.)	24

Cumulative Storm Rainfall (%)	Third Quartile (%)	Time	Cumulative Precipitation (in)
0.00	0.00	0:00	0.00
1.39	0.83	0:20	0.04
2.78	1.67	0:40	0.09
4.17	2.50	1:00	0.13
5.56	3.33	1:20	0.18
6.94	4.17	1:40	0.22
8.33	5.00	2:00	0.27
9.72	5.83	2:20	0.31
11.11	6.67	2:40	0.35
12.50	7.50	3:00	0.40
13.89	8.33	3:20	0.44
15.28	9.17	3:40	0.49
16.67	10.00	4:00	0.53
18.06	10.83	4:20	0.58
19.44	11.67	4:40	0.62
20.83	12.50	5:00	0.66
22.22	13.33	5:20	0.71
23.61	14.17	5:40	0.75
25.00	15.00	6:00	0.80
26.39	16.11	6:20	0.86
27.78	17.22	6:40	0.92
29.17	18.33	7:00	0.98
30.56	19.44	7:20	1.03
31.94	20.56	7:40	1.09
33.33	21.67	8:00	1.15
34.72	22.78	8:20	1.21
36.11	23.89	8:40	1.27
37.50	25.00	9:00	1.33
38.89	26.11	9:20	1.39
40.28	27.28	9:40	1.45
41.67	28.67	10:00	1.53
43.06	30.06	10:20	1.60
44.44	31.44	10:40	1.67
45.83	33.00	11:00	1.76
47.22	34.67	11:20	1.84
48.61	36.33	11:40	1.93
50.00	38.00	12:00	2.02
51.39	39.94	12:20	2.13
52.78	41.89	12:40	2.23
54.17	43.83	13:00	2.33
55.56	46.33	13:20	2.46
56.94	49.67	13:40	2.64
58.33	53.00	14:00	2.82

Cumulative Storm Rainfall (%)	Third Quartile (%)	Time	Cumulative Precipitation (in)
59.72	56.33	14:20	3.00
61.11	59.89	14:40	3.19
62.50	63.50	15:00	3.38
63.89	67.11	15:20	3.57
65.28	70.50	15:40	3.75
66.67	73.00	16:00	3.88
68.06	75.50	16:20	4.02
69.44	78.00	16:40	4.15
70.83	80.00	17:00	4.26
72.22	81.67	17:20	4.34
73.61	83.33	17:40	4.43
75.00	85.00	18:00	4.52
76.39	86.11	18:20	4.58
77.78	87.22	18:40	4.64
79.17	88.33	19:00	4.70
80.56	89.33	19:20	4.75
81.94	90.17	19:40	4.80
83.33	91.00	20:00	4.84
84.72	91.83	20:20	4.89
86.11	92.67	20:40	4.93
87.50	93.50	21:00	4.97
88.89	94.33	21:20	5.02
90.28	95.11	21:40	5.06
91.67	95.67	22:00	5.09
93.06	96.22	22:20	5.12
94.44	96.78	22:40	5.15
95.83	97.50	23:00	5.19
97.22	98.33	23:20	5.23
98.61	99.17	23:40	5.28
100.00	100.00	0:00	5.32

Time Interval (min) 20

1st Quartile Rainfall Distribution

Storm Event	100-year, 1-hour storm event for Clinton Landfill No. 3
Enter Rainfall Depth (in)	3.25
Storm Length (hrs.)	1

Cumulative Storm Rainfall (%)	First Quartile (%)	Time	Cumulative Precipitation (in)
0	0	0:00	0.00
5	16	0:03	0.52
10	33	0:06	1.07
15	43	0:09	1.40
20	52	0:12	1.69
25	60	0:15	1.95
30	66	0:18	2.15
35	71	0:21	2.31
40	75	0:24	2.44
45	79	0:27	2.57
50	82	0:30	2.67
55	84	0:33	2.73
60	86	0:36	2.80
65	88	0:39	2.86
70	90	0:42	2.93
75	92	0:45	2.99
80	94	0:48	3.06
85	96	0:51	3.12
90	97	0:54	3.15
95	98	0:57	3.19
100	100	1:00	3.25

Time Interval (min) 3

3rd Quartile Rainfall Distribution

Storm Event	100-year, 24-hour storm event for Clinton Landfill No. 3
Enter Rainfall Depth (in)	6.92
Storm Length (hrs.)	24

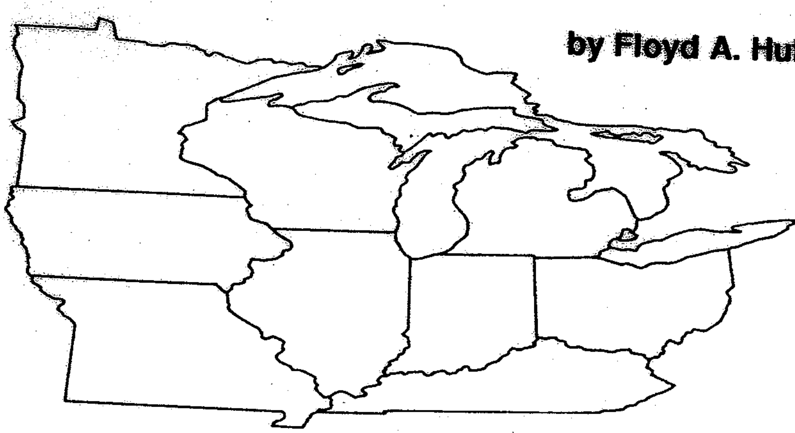
Cumulative Storm Rainfall (%)	Third Quartile (%)	Time	Cumulative Precipitation (in)
0.00	0.00	0:00	0.00
1.39	0.83	0:20	0.06
2.78	1.67	0:40	0.12
4.17	2.50	1:00	0.17
5.00	3.00	1:12	[illegible]
5.56	3.33	1:20	0.23
6.94	4.17	1:40	0.29
8.33	5.00	2:00	0.35
9.72	5.83	2:20	0.40
10.00	6.00	2:24	[illegible]
11.11	6.67	2:40	0.46
12.50	7.50	3:00	0.52
13.89	8.33	3:20	0.58
15.00	9.00	3:36	[illegible]
15.28	9.17	3:40	0.63
16.67	10.00	4:00	0.69
18.06	10.83	4:20	0.75
19.44	11.67	4:40	0.81
20.00	12.00	4:48	[illegible]
20.83	12.50	5:00	0.86
22.22	13.33	5:20	0.92
23.61	14.17	5:40	0.98
25.00	15.00	6:00	1.04
26.39	16.11	6:20	1.11
27.78	17.22	6:40	1.19
29.17	18.33	7:00	1.27
30.00	19.00	7:12	[illegible]
30.56	19.44	7:20	1.35
31.94	20.56	7:40	1.42
33.33	21.67	8:00	1.50
34.72	22.78	8:20	1.58
35.00	23.00	8:24	[illegible]
36.11	23.89	8:40	1.65
37.50	25.00	9:00	1.73
38.89	26.11	9:20	1.81
40.00	27.00	9:36	[illegible]
40.28	27.28	9:40	1.89
41.67	28.67	10:00	1.98
43.06	30.06	10:20	2.08
44.44	31.44	10:40	2.18
45.00	32.00	10:48	[illegible]
45.83	33.00	11:00	2.28
47.22	34.67	11:20	2.40

Cumulative Storm Rainfall (%)	Third Quartile (%)	Time	Cumulative Precipitation (in)
48.61	36.33	11:40	2.51
50.00	38.00	12:00	2.63
51.39	39.94	12:20	2.76
52.78	41.89	12:40	2.90
54.17	43.83	13:00	3.03
55.00	45.00	13:12	
55.56	46.33	13:20	3.21
56.94	49.67	13:40	3.44
58.33	53.00	14:00	3.67
59.72	56.33	14:20	3.90
60.00	57.00	14:24	
61.11	59.89	14:40	4.14
62.50	63.50	15:00	4.39
63.89	67.11	15:20	4.64
65.00	70.00	15:36	
65.28	70.50	15:40	4.88
66.67	73.00	16:00	5.05
68.06	75.50	16:20	5.22
69.44	78.00	16:40	5.40
70.00	79.00	16:48	
70.83	80.00	17:00	5.54
72.22	81.67	17:20	5.65
73.61	83.33	17:40	5.77
75.00	85.00	18:00	5.88
76.39	86.11	18:20	5.96
77.78	87.22	18:40	6.04
79.17	88.33	19:00	6.11
80.00	89.00	19:12	
80.56	89.33	19:20	6.18
81.94	90.17	19:40	6.24
83.33	91.00	20:00	6.30
84.72	91.83	20:20	6.35
85.00	92.00	20:24	
86.11	92.67	20:40	6.41
87.50	93.50	21:00	6.47
88.89	94.33	21:20	6.53
90.00	95.00	21:36	
90.28	95.11	21:40	6.58
91.67	95.67	22:00	6.62
93.06	96.22	22:20	6.66
94.44	96.78	22:40	6.70
95.00	97.00	22:48	
95.83	97.50	23:00	6.75
97.22	98.33	23:20	6.80
98.61	99.17	23:40	6.86
100.00	100.00	0:00	6.92

Bulletin 71
(MCC Research Report 92-03)

RAINFALL FREQUENCY ATLAS OF THE MIDWEST

by Floyd A. Huff and James R. Angel



Midwestern Climate Center
Climate Analysis Center
National Weather Service
National Oceanic and Atmospheric Administration

and

Illinois State Water Survey
A Division of the Illinois Department of Energy and Natural Resources

1992

(MCC) with Stanley Changnon and Peter J. Lamb as the co-principal investigators. The work was continued and completed under the general direction of Kenneth Kunkel, present MCC Director.

Special appreciation goes to Stan Changnon for his foresight, guidance, and encouragement in establishing and accomplishing the program objectives. He and Ken Kunkel reviewed the report and made useful comments and suggestions. Special thanks go to Richard Katz, National Center for Atmospheric Research; Tibor Farago, Hungarian Meteorological Service; and J.R.M. Hosking, IBM Research Division, for providing software for some of the extreme rainfall analyses. Fred Nurnberger, Michigan State Climatologist, provided valuable long-term precipitation data for his state as well as comments on the manuscript. We also thank the following state climatologists for their review and comments on this project: Wayne Wendland, Illinois; Ken Scheeringa, Indiana; Harry Hillaker, Iowa; Glen Conner, Kentucky; Jim Zandlo, Minnesota; Wayne Decker, Missouri; Jeff Rogers, Ohio; and Pam Naber-Knox, Wisconsin.

John Brother and Linda Hascall supervised the extensive drafting work required for the report. Jean Dennison typed and assembled the report, which Eva Kingston edited and formatted.

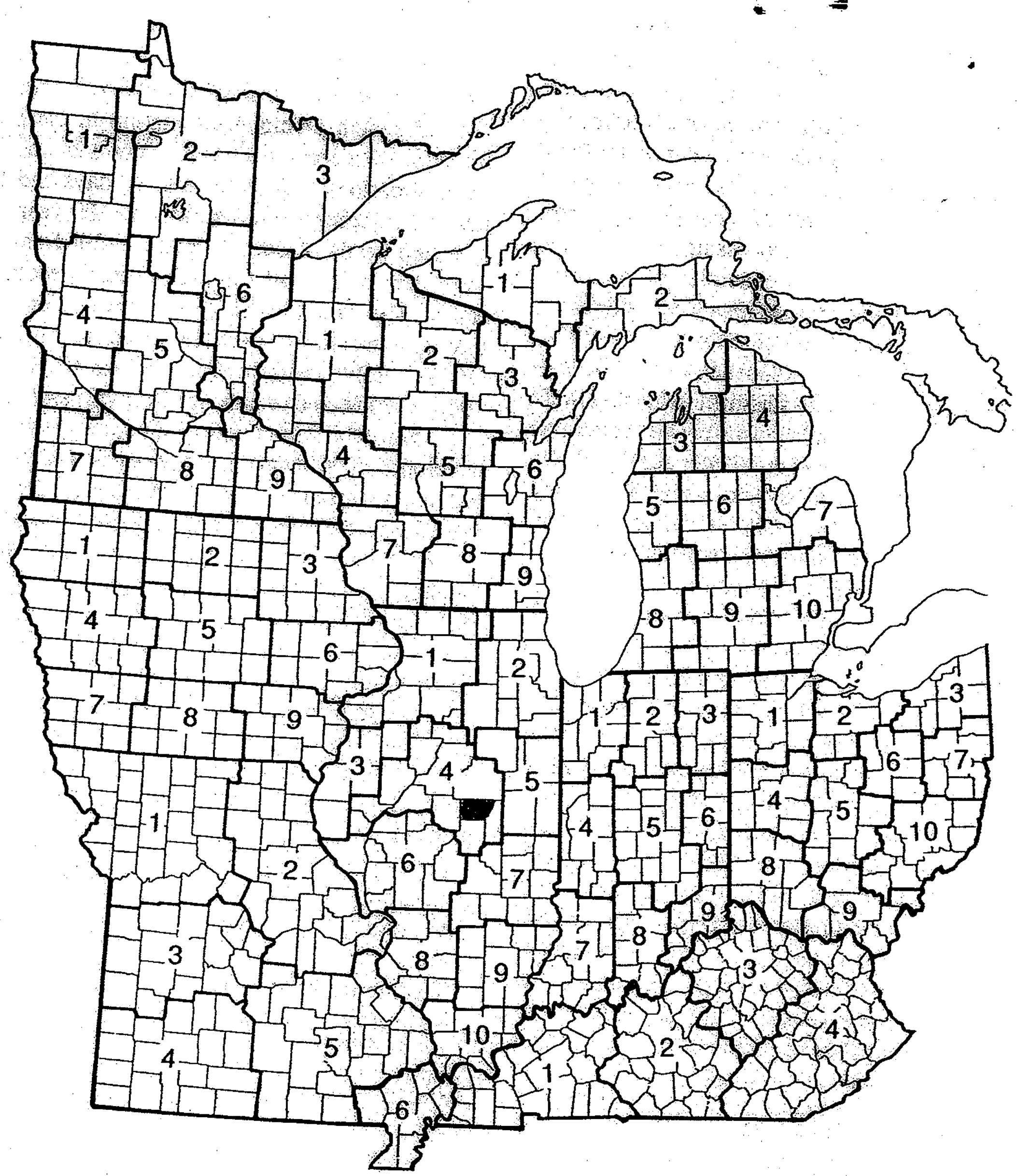


Figure 1. Climatic sections for the Midwest

Table 1. Continued

Rainfall (inches) for given recurrence interval

Section	Duration	2-month	3-month	4-month	6-month	9-month	1-year	2-year	5-year	10-year	25-year	50-year	100-year
04	10-day	2.10	2.58	2.92	3.43	3.93	4.29	5.12	6.27	7.10	8.19	9.10	10.18
04	5-day	1.77	2.12	2.37	2.78	3.20	3.48	4.17	5.11	5.84	6.96	7.98	9.21
04	72-hr	1.59	1.91	2.12	2.44	2.80	3.05	3.70	4.55	5.26	6.15	7.25	8.16
04	48-hr	1.48	1.76	1.95	2.25	2.58	2.81	3.38	4.19	4.86	5.78	6.62	7.51
04	24-hr	1.39	1.63	1.80	2.04	2.32	2.52	3.02	3.76	4.45	5.32	6.08	6.92
04	18-hr	1.27	1.51	1.66	1.88	2.12	2.28	2.75	3.46	4.09	4.90	5.59	6.37
04	12-hr	1.19	1.40	1.53	1.77	2.01	2.17	2.62	3.27	3.87	4.63	5.29	6.02
04	6-hr	1.03	1.21	1.34	1.53	1.74	1.89	2.26	2.82	3.33	3.99	4.56	5.19
04	3-hr	0.89	1.03	1.13	1.30	1.47	1.61	1.93	2.41	2.85	3.41	3.89	4.43
04	2-hr	0.82	0.95	1.04	1.19	1.37	1.48	1.78	2.22	2.62	3.14	3.59	4.08
04	1-hr	0.65	0.76	0.83	0.95	1.09	1.18	1.42	1.77	2.09	2.50	2.86	3.25
04	30-min	0.52	0.60	0.66	0.75	0.86	0.93	1.12	1.39	1.64	1.97	2.25	2.56
04	15-min	0.37	0.44	0.49	0.56	0.63	0.68	0.81	1.02	1.20	1.44	1.64	1.87
04	10-min	0.30	0.35	0.39	0.45	0.50	0.55	0.66	0.83	0.98	1.17	1.34	1.52
04	5-min	0.17	0.19	0.21	0.24	0.28	0.30	0.36	0.45	0.53	0.64	0.73	0.83
05	10-day	2.13	2.62	2.96	3.48	4.00	4.35	5.15	6.21	6.97	8.04	8.90	9.92
05	5-day	1.75	2.10	2.37	2.75	3.15	3.42	4.12	4.96	5.67	6.76	7.65	8.78
05	72-hr	1.61	1.93	2.16	2.48	2.85	3.10	3.71	4.57	5.20	6.17	6.97	7.83
05	48-hr	1.51	1.77	1.95	2.26	2.57	2.82	3.40	4.16	4.77	5.66	6.40	7.16
05	24-hr	1.36	1.58	1.75	2.00	2.27	2.47	3.01	3.71	4.26	5.04	5.83	6.61
05	18-hr	1.25	1.47	1.62	1.84	2.09	2.27	2.77	3.41	3.92	4.63	5.37	6.08
05	12-hr	1.18	1.38	1.53	1.74	1.98	2.15	2.62	3.23	3.71	4.38	5.08	5.75
05	6-hr	1.00	1.18	1.32	1.49	1.70	1.85	2.26	2.78	3.20	3.78	4.38	4.96
05	3-hr	0.87	1.02	1.12	1.28	1.46	1.58	1.93	2.37	2.73	3.22	3.74	4.23
05	2-hr	0.79	0.93	1.03	1.17	1.34	1.46	1.78	2.19	2.52	2.97	3.44	3.90
05	1-hr	0.64	0.74	0.81	0.93	1.07	1.16	1.41	1.74	2.00	2.39	2.74	3.11
05	30-min	0.50	0.58	0.64	0.74	0.84	0.91	1.11	1.37	1.57	1.87	2.16	2.45
05	15-min	0.37	0.43	0.47	0.54	0.62	0.67	0.81	1.00	1.14	1.37	1.60	1.85
05	10-min	0.30	0.35	0.38	0.43	0.49	0.54	0.66	0.81	0.94	1.12	1.28	1.46
05	5-min	0.17	0.19	0.21	0.24	0.28	0.30	0.36	0.44	0.51	0.61	0.70	0.79
06	10-day	2.16	2.65	2.99	3.52	4.05	4.40	5.35	6.62	7.45	8.66	9.79	11.26
06	5-day	1.77	2.13	2.39	2.78	3.19	3.47	4.19	5.32	6.20	7.44	8.53	9.93
06	72-hr	1.63	1.95	2.16	2.50	2.88	3.13	3.81	4.85	5.68	6.84	7.76	8.92
06	48-hr	1.52	1.81	2.00	2.30	2.64	2.87	3.49	4.45	5.21	6.28	7.12	8.19
06	24-hr	1.42	1.66	1.84	2.10	2.38	2.59	3.11	3.93	4.65	5.57	6.46	7.45
06	18-hr	1.31	1.53	1.68	1.93	2.19	2.38	2.86	3.61	4.28	5.12	5.95	6.85
06	12-hr	1.24	1.44	1.57	1.82	2.07	2.25	2.71	3.39	3.97	4.84	5.62	6.48
06	6-hr	1.07	1.24	1.37	1.57	1.78	1.94	2.33	2.95	3.48	4.18	4.85	5.59
06	3-hr	0.91	1.07	1.18	1.34	1.52	1.66	1.99	2.51	2.98	3.56	4.14	4.77
06	2-hr	0.84	0.98	1.08	1.24	1.41	1.53	1.84	2.32	2.74	3.28	3.81	4.39
06	1-hr	0.67	0.79	0.87	0.99	1.12	1.21	1.46	1.85	2.19	2.62	3.04	3.50
06	30-min	0.53	0.61	0.68	0.78	0.88	0.96	1.15	1.46	1.72	2.06	2.39	2.75
06	15-min	0.38	0.45	0.49	0.57	0.64	0.70	0.84	1.06	1.26	1.52	1.75	2.01
06	10-min	0.31	0.36	0.40	0.46	0.52	0.57	0.68	0.87	1.02	1.22	1.42	1.64
06	5-min	0.17	0.20	0.22	0.25	0.29	0.31	0.37	0.47	0.56	0.67	0.78	0.89

Table 10. Median Time Distributions of Heavy Storm Rainfall at a Point

Cumulative storm time (percent)	*Cumulative storm rainfall (percent) for given storm type*			
	First-quartile (1-hr)	*Second-quartile*	*Third-quartile* (24-hr)	*Fourth-quartile*
5	16	3	3	2
10	33	8	6	5
15	43	12	9	8
20	52	16	12	10
25	60	22	15	13
30	66	29	19	16
35	71	39	23	19
40	75	51	27	22
45	79	62	32	25
50	82	70	38	28
55	84	76	45	32
60	86	81	57	35
65	88	85	70	39
70	90	88	79	45
75	92	91	85	51
80	94	93	89	59
85	96	95	92	72
90	97	97	95	84
95	98	98	97	92

WATERSHED DELINEATION

Shaw® Shaw Environmental, Inc.

Client: Clinton Landfill, Inc.
Project: Clinton Landfill No. 3
Proj.#: 128017
Calculated By: LJC Date: 9/14/07
Checked by: JPV Date: 9/17/07

TITLE: WATERSHED DELINEATION

Problem Statement

Delineate the watersheds for the final site conditions for the Clinton Landfill No. 3.

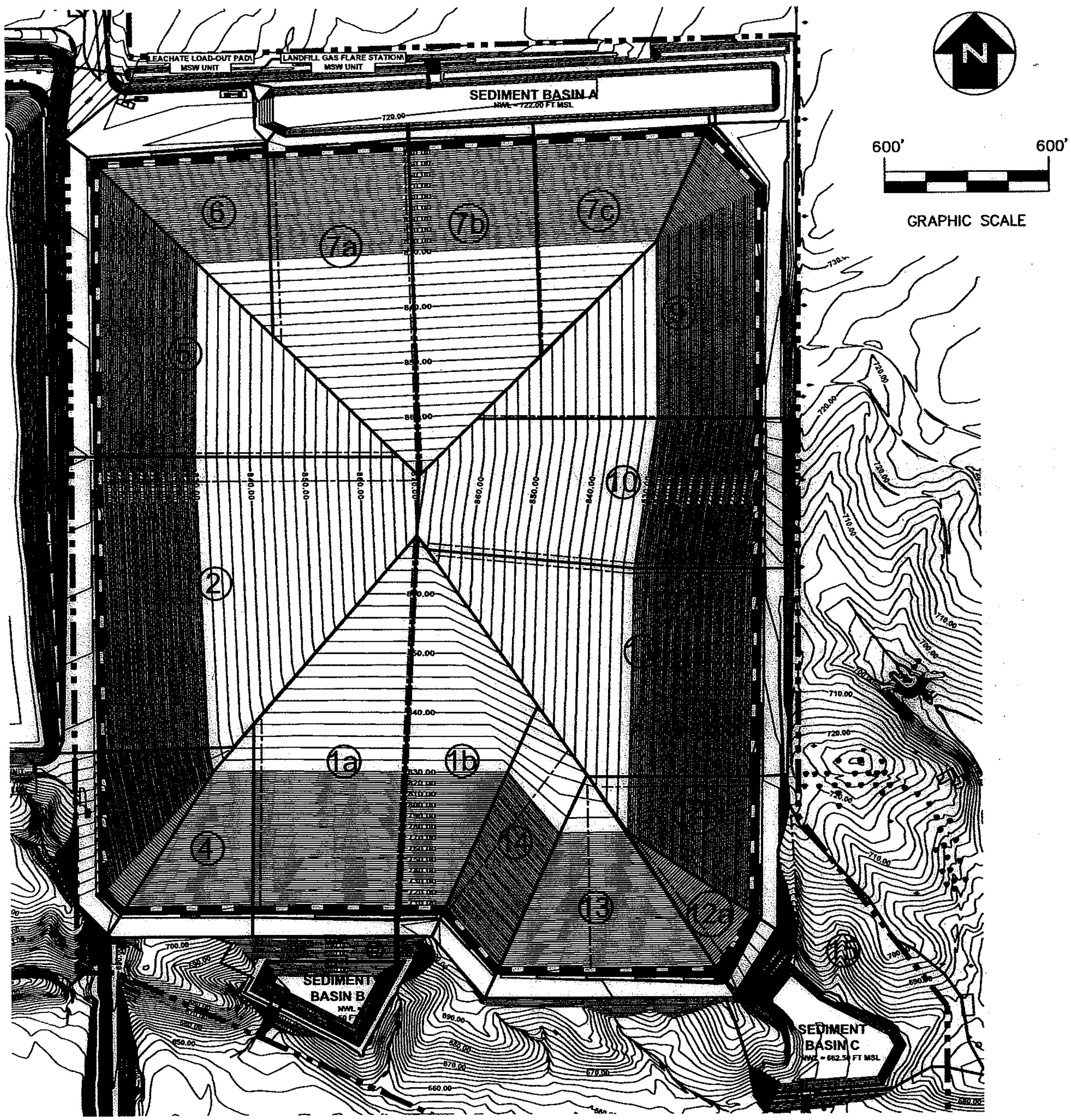
Given

The watersheds were reviewed using Figure M.2-1.

Results

Attached are delineations of the drainage areas of the final site conditions. The following table summarizes the acreage of all drainage areas. The longest flow lengths were also included in the table. This value is needed to calculate the travel time for a drop of water to travel through the subarea.

Proposed Final Conditions				
Subarea	**Area (sf)**	**Area (ac)**	**Area (mi2)**	**Overland Flow Length (ft)**
Subareas Draining to Sediment Basin A				
5	716,516	16.45	0.0257	1,103
6	369,674	8.49	0.0133	689
7a	514,036	11.80	0.0184	1,209
7b	469,302	10.77	0.0168	1,209
7c	330,699	7.59	0.0119	800
9	676,666	15.53	0.0243	1,045
Subareas Draining to Sediment Basin B				
1a	620,881	14.25	0.0223	1,386
1b	403,462	9.26	0.0145	1,386
2	1,121,280	25.74	0.0402	1,103
3	224,434	5.15	0.0081	500
4	221,009	5.07	0.0079	674
14	245,828	5.64	0.0088	782
17	99,975	2.30	0.0036	147
Subareas Draining to Sediment Basin C				
10	680,053	15.61	0.0244	1,179
11	782,109	17.95	0.0281	1,179
12a	93,275	2.14	0.0033	534
12b	234,896	5.39	0.0084	598
13	374,877	8.61	0.0134	701
15	379,873	8.72	0.0136	560



LEGEND

APPROXIMATE FACILITY BOUNDARY

APPROXIMATE EXISTING WASTE BOUNDARY

DRAINAGE DIVIDE

TIME OF CONCENTRATION FLOW LENGTH

NOTES

1. FOR CLARITY, NOT ALL SITE FEATURES MAY BE SHOWN.

Shaw® Shaw Environmental, Inc.

CHEMICAL WASTE LANDFILL
CLINTON LANDFILL NO. 3

FIGURE M.2-1
WATERSHED DELINEATION
FINAL CONDITIONS

APPROVED BY: DAM	PROJ. NO.: 128017	DATE: OCT 2007

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DETERMINATION OF WEIGHTED CURVE NUMBER

Shaw®

Shaw® Shaw Environmental, Inc.

Client: Clinton Landfill, Inc.
Project: Clinton Landfill No. 3
Proj.#: 128017
Calculated By: LJC **Date:** 9/18/07
Checked by: JPV **Date:** 9/19/07

TITLE: DETERMINATION OF WEIGHTED CURVE NUMBER

Objective

Determine the weighted curve number to be used for runoff calculations of the Final Landform.

Results

Although a curve number of 80 is typical of a properly managed final landfill, a curve number of 85 will be used for the watersheds on the final landform. Based on curve number listed in TR55 for pasture, grassland, meadow and brush, a value of 85 is conservative. Using a curve number of 85 in the HEC-HMS model will result in more runoff than is anticipated.

United States
Department of
Agriculture

Soil
Conservation
Service

Engineering
Division

Technical
Release 55

June 1986

Urban Hydrology for Small Watersheds

Table 2-2c.—Runoff curve numbers for other agricultural lands[1]

Cover description		Curve numbers for hydrologic soil group—			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing.[2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element.[3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	[4]30	48	65	73
Woods—grass combination (orchard or tree farm).[5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods.[6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	[4]30	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

[1]Average runoff condition, and $I_a = 0.2S$.

[2]*Poor:* <50% ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: >75% ground cover and lightly or only occasionally grazed.

[3]*Poor:* <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

[4]Actual curve number is less than 30; use CN = 30 for runoff computations.

[5]CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

[6]*Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

DETERMINATION OF SCS LAG TIME

Shaw®

Shaw® Shaw Environmental, Inc.

Client: Clinton Landfill, Inc.
Project: Clinton Landfill No. 3
Proj.#: 128017
Calculated By: LJC Date: 9/14/07
Checked by: JPV Date: 9/17/07

TITLE: DETERMINATION OF SCS LAG TIME

Problem Statement

Determine the SCS Lag Time for the final landform watersheds for the Clinton Landfill No. 3. The SCS Lag Time is equal to the lag time between the center of mass of rainfall excess and the peak of the unit hydrograph and is an input parameter for the HEC-HMS computer model to determine stormwater runoff.

Given

- The longest hydraulic flow paths for the proposed site conditions were determined from the proposed final landform drawings. (See attached figures in Appendix M.2.b - Watershed Delineation.)
- The time of concentration was calculated using the method outlined in Technical Release 55 (TR-55), Urban Hydrology for Small Watersheds, published by the Soil Conservation Service. (Refer to attached pages).
- The SCS lag time is equal to the time of concentration of the watershed multiplied by 0.6 (Refer to pages 6-8 of the ProHEC1 Plus manual).
- Roberson, J.A. and C.T. Crowe, Engineering Fluid Mechanics. John Wiley & Sons, Inc. (Refer to attached pages).

Assumptions

The following assumptions were made in the calculations:

- The Manning's n for sheet flow on the final landform is assumed to be 0.15 (short grass prairie). This number is appropriate for the type of grass anticipated to grow on the landform after final closure.
- An average slope for final conditions was calculated since the slope along the flow lengths vary.
- The Manning's n for the proposed and existing channels and the terrace ditches is assumed to be 0.023. This value is for an unlined, earth, straight, and uniform channel and is the lowest Manning's n probable. A higher Manning's number would be appropriate for a rockier or more vegetated channel. Since a higher Manning's number would result in longer time of concentrations and therefore a lower peak discharge, this assumption is conservative.
- The 2-year, 24-hour rain event provides the shortest time of concentrations and highest peak discharge. The 2-year, 24-hour rainfall is 3.02 inches. Refer to Calculation, "Determination of Rainfall Totals and Distributions".

Shaw® Shaw Environmental, Inc.

Client: Clinton Landfill, Inc.
Project: Clinton Landfill No. 3
Proj.#: 128017
Calculated By: LJC Date: 9/14/07
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TITLE: DETERMINATION OF SCS LAG TIME

- Terrace berms and downslopes ditches will be used to control erosion and minimize sedimentation during the final grading plan of the landfill as described in the Stormwater Management Plan. However, the calculation of the SCS Lag Time does not include these features, to maintain a more conservative design approach. The use of terrace berms and riprapped downslopes will typically increase the time of concentration allowing a lower peak flow.

Calculations

For each watershed the time of concentration, T_c, is the sum of the travel times, T_t, of various consecutive flow segments. There are three types of flow: sheet flow, shallow concentrated flow, and open channel flow.

Sheet Flow:
Sheet flow is flow over plane surfaces and is computed using the following equation.

$$T_t = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} s^{0.4}}$$

Where:

n = Manning roughness coefficient, unitless
L = Flow Length, ft
P_2 = 24-hour, 2-year rainfall = 3.02 inches
s = slope, ft/ft

After 300 feet, sheet flow becomes shallow concentrated flow.

Shallow Concentrated Flow:

The average velocity for shallow concentrated flow is calculated using figure 3-1: Average velocities for estimating travel time for shallow concentrated flow from Technical Release 55 (TR-55), Urban Hydrology for Small Watersheds.

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Client:	Clinton Landfill, Inc.		
Project:	Clinton Landfill No. 3		
Proj.#:	128017		
Calculated By:	LJC	Date:	9/14/07
Checked by:	JPV	Date:	9/17/07

TITLE: DETERMINATION OF SCS LAG TIME

The travel time is then calculated using the following equation.

$$T_t = \frac{L}{3{,}600V}$$

Where:

L = Flow Length, ft
V = Average velocity, ft/sec
3,600 = Conversion factor from seconds to hours

Open Channel Flow:

Average velocity for open channels is calculated using the following equation.

$$V = \frac{1.49 r^{2/3} s^{1/2}}{n}$$

Where:

V = Average velocity, ft/sec
r = hydraulic radius, ft and is equal to a/p_w
a = cross sectional flow area, ft^2
p_w = wetted perimeter, ft
n = Manning roughness coefficient
s = slope, ft/ft

The time of concentration for the watershed is then the summation of all travel times.

$$T_c = T_{t1} + T_{t2} + T_{t3} + \ldots.$$

To calculate the SCS lag time, the time of concentration is then multiplied by 0.6.

$$T_{lag} = 0.6\, T_c$$

There are no channel flows for the subareas in this case because it is calculated in the HEC-HMS model via the ditches.

Results

For each watershed, all travel times, times of concentration, SCS lag times, as well as the necessary input parameters, are summarized in the attached spreadsheet.

CHEMICAL WASTE LANDFILL - CLINTON LANDFILL NO. 3
SCS LAG COMPUTATION - TR55 METHOD

2-year, 24-hour rainfall (inches) = 3.02
Manning's coefficient for channel flow (open flow) = 0.023

	SHEET FLOW				SHALLOW CONCENTRATED FLOW				CHANNEL FLOW*						RESULTS				
Subareas	Length (ft)	Cover	n	Slope (ft/ft)	Length (ft)	Cover	Slope (ft/ft)	Velocity (ft/sec)	Length (ft)	Slope (ft/ft)	Depth (ft)	A (ft^2)	pw (ft)	Velocity (ft/sec)	Tt - Sheet (min)	Tt - Shallow Conc. (min)	Tt-Channel (min)	Tc (min)	SCS Lag Time (min)
Subareas Draining to Sediment Basin A																			
5	300.0	Short Grass Prairie	0.15	0.0500	803.0	Unpaved	0.1432	6.11	0.0	0.0	0.0	0.0	0.0	0.0	16.8356	2.1920	0.0000	19.0276	11.42
6	300.0	Short Grass Prairie	0.15	0.0633	389.0	Unpaved	0.2500	8.07	0.0	0.0	0.0	0.0	0.0	0.0	15.3198	0.8037	0.0000	16.1235	9.67
7a	300.0	Short Grass Prairie	0.15	0.0500	909.0	Unpaved	0.1289	5.79	0.0	0.0	0.0	0.0	0.0	0.0	16.8356	2.6154	0.0000	19.4509	11.67
7b	300.0	Short Grass Prairie	0.15	0.0500	909.0	Unpaved	0.1289	5.79	0.0	0.0	0.0	0.0	0.0	0.0	16.8356	2.6154	0.0000	19.4509	11.67
7c	300.0	Short Grass Prairie	0.15	0.0500	500.0	Unpaved	0.2100	7.39	0.0	0.0	0.0	0.0	0.0	0.0	16.8356	1.1271	0.0000	17.9626	10.78
9	300.0	Short Grass Prairie	0.15	0.0500	745.0	Unpaved	0.1540	6.33	0.0	0.0	0.0	0.0	0.0	0.0	16.8356	1.9611	0.0000	18.7966	11.28
Subareas Draining to Sediment Basin B																			
1a	300.0	Short Grass Prairie	0.15	0.0500	1,086.0	Unpaved	0.1464	6.17	0.0	0.0	0.0	0.0	0.0	0.0	16.8356	2.9319	0.0000	19.7675	11.86
1b	300.0	Short Grass Prairie	0.15	0.0500	1,086.0	Unpaved	0.1464	6.17	0.0	0.0	0.0	0.0	0.0	0.0	16.8356	2.9319	0.0000	19.7675	11.86
2	300.0	Short Grass Prairie	0.15	0.0500	803.0	Unpaved	0.1432	6.11	0.0	0.0	0.0	0.0	0.0	0.0	16.8356	2.1920	0.0000	19.0276	11.42
3	300.0	Short Grass Prairie	0.15	0.1867	200.0	Unpaved	0.2500	8.07	0.0	0.0	0.0	0.0	0.0	0.0	9.9394	0.4132	0.0000	10.3525	6.21
4	300.0	Short Grass Prairie	0.15	0.1333	374.0	Unpaved	0.2500	8.07	0.0	0.0	0.0	0.0	0.0	0.0	11.3732	0.7727	0.0000	12.1459	7.29
14	300.0	Short Grass Prairie	0.15	0.0700	482.0	Unpaved	0.2241	7.64	0.0	0.0	0.0	0.0	0.0	0.0	14.7156	1.0518	0.0000	15.7673	9.46
17	147.0	Short Grass Prairie	0.15	0.2040	0.0	Unpaved	0.0000	n/a	0.0	0.0	0.0	0.0	0.0	0.0	5.4215	0.0000	0.0000	5.4215	3.25
Subareas Draining to Sediment Basin C																			
10	300.0	Short Grass Prairie	0.15	0.0500	879.0	Unpaved	0.1479	6.20	0.0	0.0	0.0	0.0	0.0	0.0	16.8356	0.0000	0.0000	16.8356	10.10
11	300.0	Short Grass Prairie	0.15	0.0500	879.0	Unpaved	0.1479	6.20	0.0	0.0	0.0	0.0	0.0	0.0	16.8356	0.0000	0.0000	16.8356	10.10
12a	300.0	Short Grass Prairie	0.15	0.2133	234.0	Unpaved	0.2051	7.31	0.0	0.0	0.0	0.0	0.0	0.0	9.4237	0.0000	0.0000	9.4237	5.65
12b	300.0	Short Grass Prairie	0.15	0.1500	298.0	Unpaved	0.2500	8.07	0.0	0.0	0.0	0.0	0.0	0.0	10.8487	0.0000	0.0000	10.8487	6.51
13	300.0	Short Grass Prairie	0.15	0.1000	401.0	Unpaved	0.2500	8.07	0.0	0.0	0.0	0.0	0.0	0.0	12.7590	0.0000	0.0000	12.7590	7.66
15	300.0	Short Grass Prairie	0.15	0.0900	260.0	Unpaved	0.0962	5.00	0.0	0.0	0.0	0.0	0.0	0.0	13.3082	0.0000	0.0000	13.3082	7.98

United States
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Soil
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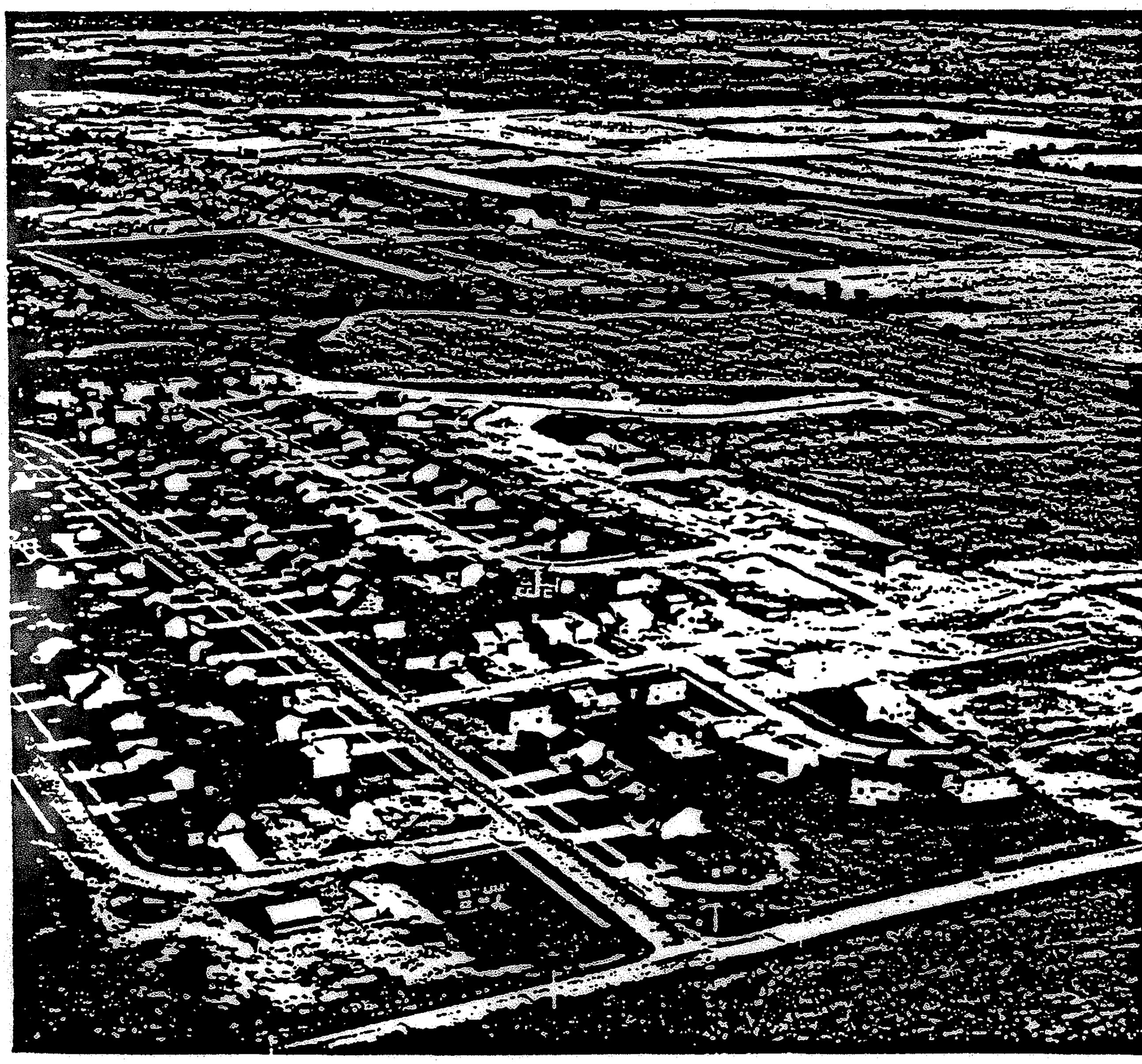
Service

Engineering
Division

Technical
Release 55

June 1986

Urban Hydrology for Small Watersheds



Chapter 3: Time of concentration and travel time

Travel time (T_t) is the time it takes water to travel from one location to another in a watershed. T_t is a component of time of concentration (T_c), which is the time for runoff to travel from the hydraulically most distant point of the watershed to a point of interest within the watershed. T_c is computed by summing all the travel times for consecutive components of the drainage conveyance system.

T_c influences the shape and peak of the runoff hydrograph. Urbanization usually decreases T_c, thereby increasing the peak discharge. But T_c can be increased as a result of (a) ponding behind small or inadequate drainage systems, including storm drain inlets and road culverts, or (b) reduction of land slope through grading.

Factors affecting time of concentration and travel time

Surface roughness

One of the most significant effects of urban development on flow velocity is less retardance to flow. That is, undeveloped areas with very slow and shallow overland flow through vegetation become modified by urban development: the flow is then delivered to streets, gutters, and storm sewers that transport runoff downstream more rapidly. Travel time through the watershed is generally decreased.

Channel shape and flow patterns

In small non-urban watersheds, much of the travel time results from overland flow in upstream areas. Typically, urbanization reduces overland flow lengths by conveying storm runoff into a channel as soon as possible. Since channel designs have efficient hydraulic characteristics, runoff flow velocity increases and travel time decreases.

Slope

Slopes may be increased or decreased by urbanization, depending on the extent of site grading or the extent to which storm sewers and street ditches are used in the design of the water management system. Slope will tend to increase when channels are straightened and decrease when overland flow is directed through storm sewers, street gutters, and diversions.

Computation of travel time and time of concentration

Water moves through a watershed as sheet flow, shallow concentrated flow, open channel flow, or some combination of these. The type that occurs is a function of the conveyance system and is best determined by field inspection.

Travel time (T_t) is the ratio of flow length to flow velocity:

$$T_t = \frac{L}{3600\ V} \qquad \text{[Eq. 3-1]}$$

where

T_t = travel time (hr),
L = flow length (ft),
V = average velocity (ft/s), and
3600 = conversion factor from seconds to hours.

Time of concentration (T_c) is the sum of T_t values for the various consecutive flow segments:

$$T_c = T_{t_1} + T_{t_2} + \dots T_{t_m} \qquad \text{[Eq. 3-2]}$$

where

T_c = time of concentration (hr) and
m = number of flow segments.

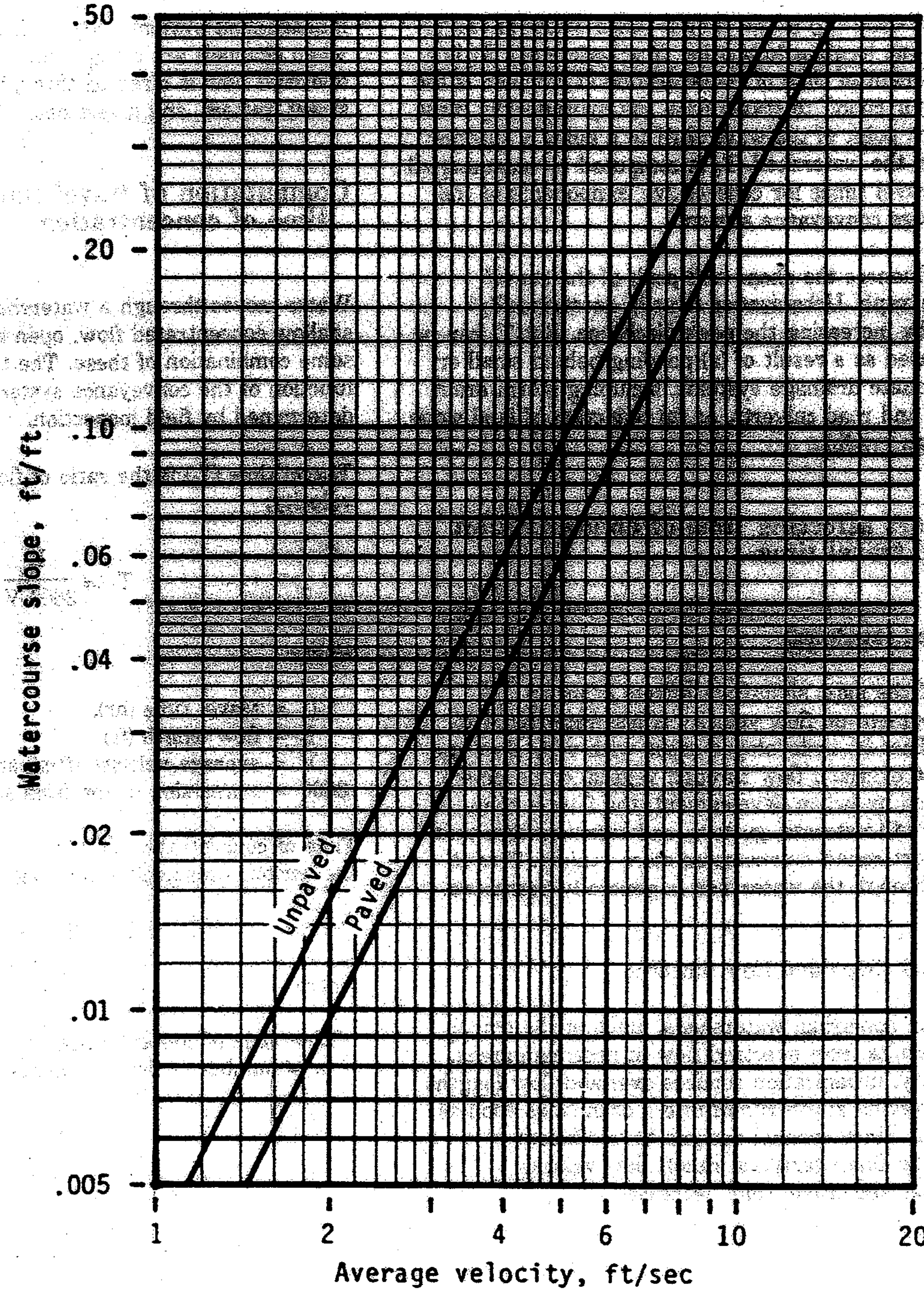


Figure 3-1.—Average velocities for estimating travel time for shallow concentrated flow.

Sheet flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges, and rocks; and erosion and transportation of sediment. These n values are for very shallow flow depths of about 0.1 foot or so. Table 3-1 gives Manning's n values for sheet flow for various surface conditions.

For sheet flow of less than 300 feet, use Manning's kinematic solution (Overton and Meadows 1976) to compute T_t:

$$T_t = \frac{0.007\,(nL)^{0.8}}{(P_2)^{0.5}\,s^{0.4}} \qquad \text{[Eq. 3-3]}$$

Table 3-1.—Roughness coefficients (Manning's n) for sheet flow

Surface description	n[1]
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover ≤20%	0.06
Residue cover >20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses[2]	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods:[3]	
Light underbrush	0.40
Dense underbrush	0.80

[1]The n values are a composite of information compiled by Engman (1986).
[2]Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
[3]When selecting n, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

where

T_t = travel time (hr),
n = Manning's roughness coefficient (table 3-1),
L = flow length (ft),
P_2 = 2-year, 24-hour rainfall (in), and
s = slope of hydraulic grade line (land slope, ft/ft).

This simplified form of the Manning's kinematic solution is based on the following: (1) shallow steady uniform flow, (2) constant intensity of rainfall excess (that part of a rain available for runoff), (3) rainfall duration of 24 hours, and (4) minor effect of infiltration on travel time. Rainfall depth can be obtained from appendix B.

Shallow concentrated flow

After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from figure 3-1, in which average velocity is a function of watercourse slope and type of channel. For slopes less than 0.005 ft/ft, use equations given in appendix F for figure 3-1. Tillage can affect the direction of shallow concentrated flow. Flow may not always be directly down the watershed slope if tillage runs across the slope.

After determining average velocity in figure 3-1, use equation 3-1 to estimate travel time for the shallow concentrated flow segment.

Open channels

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheets. Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bank-full elevation.

Manning's equation is

$$V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n} \qquad \text{[Eq. 3-4]}$$

where

V = average velocity (ft/s),
r = hydraulic radius (ft) and is equal to a/p_w,
a = cross sectional flow area (ft^2),
p_w = wetted perimeter (ft),
s = slope of the hydraulic grade line (channel slope, ft/ft), and
n = Manning's roughness coefficient for open channel flow.

Manning's n values for open channel flow can be obtained from standard textbooks such as Chow (1959) or Linsley et al. (1982). After average velocity is computed using equation 3-4, T_t for the channel segment can be estimated using equation 3-1.

Reservoirs or lakes

Sometimes it is necessary to estimate the velocity of flow through a reservoir or lake at the outlet of a watershed. This travel time is normally very small and can be assumed as zero.

Limitations

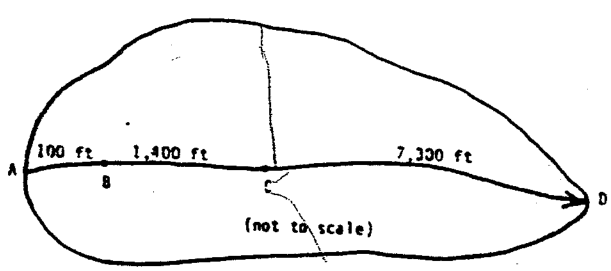
- Manning's kinematic solution should not be used for sheet flow longer than 300 feet. Equation 3-3 was developed for use with the four standard rainfall intensity-duration relationships.
- In watersheds with storm sewers, carefully identify the appropriate hydraulic flow path to estimate T_c. Storm sewers generally handle only a small portion of a large event. The rest of the peak flow travels by streets, lawns, and so on, to the outlet. Consult a standard hydraulics textbook to determine average velocity in pipes for either pressure or nonpressure flow.
- The minimum T_c used in TR-55 is 0.1 hour.
- A culvert or bridge can act as a reservoir outlet if there is significant storage behind it. The procedures in TR-55 can be used to determine the peak flow upstream of the culvert. Detailed storage routing procedures should be used to determine the outflow through the culvert.

Example 3-1

The sketch below shows a watershed in Dyer County, northwestern Tennessee. The problem is to compute T_c at the outlet of the watershed (point D). The 2-year 24-hour rainfall depth is 3.6 inches. All three types of flow occur from the hydraulically most distant point (A) to the point of interest (D). To compute T_c, first determine T_t for each segment from the following information:

Segment AB: Sheet flow; dense grass; slope (s) = 0.01 ft/ft; and length (L) = 100 ft.
Segment BC: Shallow concentrated flow; unpaved: s = 0.01 ft/ft; and L = 1400 ft.
Segment CD: Channel flow; Manning's n = .05; flow area (a) = 27 ft^2; wetted perimeter (p_w) = 28.2 ft; s = 0.005 ft/ft; and L = 7300 ft.

See figure 3-2 for the computations made on worksheet 3.



Appendix F: Equations for figures and exhibits

This appendix presents the equations used in procedure applications to generate figures and exhibits in TR-55.

Figure 2-1 (runoff equation):

$$Q = \frac{\left[P - 0.2\left(\frac{1000}{CN} - 10\right)\right]^2}{P + 0.8\left(\frac{1000}{CN} - 10\right)}$$

where

Q = runoff (in),
P = rainfall (in), and
CN = runoff curve number.

Figure 2-3 (composite CN with connected impervious area):

$$CN_c = CN_p + (P_{imp}/100)(98 - CN_p)$$

where

CN_c = composite runoff curve number,
CN_p = pervious runoff curve number, and
P_{imp} = percent imperviousness.

Figure 2-4 (composite CN with unconnected impervious areas and total impervious area less than 30%):

$$CN_c = CN_p + (P_{imp}/100)(98 - CN_p)(1 - 0.5R)$$

where R = ratio of unconnected impervious area to total impervious area.

Figure 3-1 (average velocities for estimating travel time for shallow concentrated flow):

Unpaved $V = 16.1345\,(s)^{0.5}$
Paved $V = 20.3282\,(s)^{0.5}$

where

V = average velocity (ft/s), and
s = slope of hydraulic grade line (watercourse slope, ft/ft).

These two equations are based on the solution of Manning's equation (Eq. 3-4) with different assumptions for n (Manning's roughness coefficient) and r (hydraulic radius, ft). For unpaved areas, n is 0.05 and r is 0.4; for paved areas, n is 0.025 and r is 0.2.

Exhibit 4 (unit peak discharges for SCS type I, IA, II, and III distributions):

$$\log(q_u) = C_0 + C_1 \log(T_c) + C_2 [\log(T_c)]^2$$

where

q_u = unit peak discharge (csm/in),
T_c = time of concentration (hr) (minimum, 0.1; maximum, 10.0), and
C_0, C_1, C_2 = coefficients from table F-1.

Figure 6-1 (approximate detention basin routing through single- and multiple-stage structures for 24-hour rainfalls of the indicated type):

$$V_s/V_r = C_0 + C_1 (q_o/q_i) + C_2 (q_o/q_i)^2 + C_3 (q_o/q_i)^3$$

where

V_s/V_r = ratio of storage volume (V_s) to runoff volume (V_r),
q_o/q_i = ratio of peak outflow discharge (q_o) to peak inflow discharge (q_i), and
C_0, C_1, C_2, C_3 = coefficients from table F-2.

THE DODSON PROFESSIONAL HEC-1 SYSTEM

An Enhanced Version of the Standard Corps of Engineers' Watershed Modeling Computer Program

ProHEC1 *Plus*

Program Documentation

DODSON
& ASSOCIATES, INC.
Hydrologists and Civil Engineers

The unit hydrograph is interpolated for the specified computation interval and computed peak flow rate from the dimensionless unitgraph shown in Figure 6.4. The dimensionless unitgraph ratios are listed in Table 6.4.

Since the program computation interval is used in the computation of T_{PEAK} and Q_{PEAK} for the unit hydrograph, changing the computation interval will affect the computed unit hydrograph. The SCS Dimensionless hydrograph was originally formulated by assuming that $\Delta t = 0.2 \times T_{PEAK}$. To minimize errors, the computation interval Δt used in HEC-1 should be less than or equal to $0.29 \times T_{PEAK}$. The SCS also assumed that $\boxed{T_{LAG} = 0.6 \times T_C}$ and that $1.7 \times T_{PEAK} = \Delta t + T_C$ where T_C is the time of concentration of the watershed. Using these relationships, along with equation 6.2, it is evident that the computation interval Δt should be less than or equal to $0.29 \times T_{LAG}$.

FIGURE 6.4 SCS Dimensionless Unitgraph Method

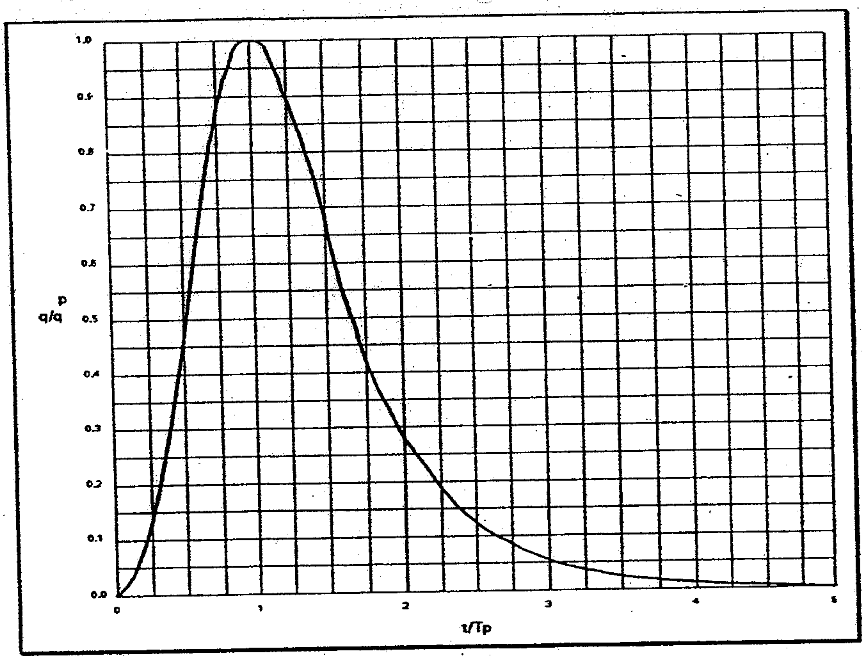


TABLE 6.4 SCS Dimensionless Unitgraph Discharge Ratios

Time Ratios (t/Tp)	Discharge Ratios (q/qp)	Time Ratios (t/Tp)	Discharge Ratios (q/qp	Time Ratios (t/Tp)	Discharge Ratios (q/qp)
0.0	0.000	1.1	0.990	2.4	0.147
0.1	0.030	1.2	0.930	2.6	0.107
0.2	0.100	1.3	0.860	2.8	0.077
0.3	0.190	1.4	0.780	3.0	0.055
0.4	0.310	1.5	0.680	3.2	0.040
0.5	0.470	1.6	0.560	3.4	0.029
0.6	0.660	1.7	0.460	3.6	0.021
0.7	0.820	1.8	0.390	3.8	0.015
0.8	0.930	1.9	0.330	4.0	0.011
0.9	0.990	2.0	0.280	4.5	0.005
1.0	1.000	2.2	0.207	5.0	0.000

Clark Unit Hydrograph Computation

The HEC-1 UC record and an optional set of UA records are used to enter the input data necessary to compute a unit hydrograph using the Clark method. The Clark method requires three

ENGINEERING FLUID MECHANICS

SIXTH EDITION

JOHN A. ROBERSON
CLAYTON T. CROWE

When we insert this expression for C into Eq. (10.42), we obtain a common form of the discharge equation for uniform flow in open channels for SI units:

$$Q = \frac{1.0}{n} A R_h^{2/3} S_0^{1/2} \tag{10.44}$$

In Eq. (10.44), n is a resistance coefficient called Manning's n, which has different values for different types of boundary roughness. Table 10.3 gives n for various types of boundary surfaces. The major limitation of this approach is that the viscous or relative roughness effects are not present in the design formula. Hence, application outside the range of normal-sized channels carrying water is not recommended.

Manning Equation—Traditional System of Units

It can be shown that, in converting from SI to the traditional system of units, one must apply a factor equal to 1.49 if the same value of n is used in the two

[illegible]

Lined Canals	n
Cement plaster	0.011
Untreated gunite	0.016
Wood, planed	0.012
Wood, unplaned	0.013
Concrete, troweled	0.012
Concrete, wood forms, unfinished	0.015
Rubble in cement	0.020
Asphalt, smooth	0.013
Asphalt, rough	0.016
Corrugated metal	0.024
Unlined Canals	
Earth, straight and uniform	0.023
Earth, winding and weedy banks	0.035
Cut in rock, straight and uniform	0.030
Cut in rock, jagged and irregular	0.045
Natural Channels	
Gravel beds, straight	0.025
Gravel beds plus large boulders	0.040
Earth, straight, with some grass	0.026
Earth, winding, no vegetation	0.030
Earth, winding, weedy banks	0.050
Earth, very weedy and overgrown	0.080

ORIFICE DISCHARGE CALCULATIONS

Shaw®

Shaw® Shaw Environmental, Inc.

Client:	Clinton Landfill, Inc.
Project:	Clinton Landfill No. 3
Proj. #:	128017
Calculated By:	LJC	Date: 10/5/07
Checked By:	JPV	Date: 10/5/07

TITLE: ORIFICE DISCHARGE CALCULATIONS

Problem Statement

Develop a discharge versus water elevation for the proposed spillway of Sediment Basin A, Sediment Basin B and Sediment Basin C. This chart will then be an input parameter for the HEC-HMS model used to determine stormwater runoff.

Given

References

- "Hydrology and Floodplain Analysis" by Philip B. Bedient of Rice University and Wayne C. Huber of University of Florida

Outlet Structure Design Parameters

Sediment Basin A

The primary outlet structure consists of a perforated standpipe with perforations beginning at elevation 722.0 (Normal Water Level). The standpipe is connected to a 24" culvert which is fitted with a valve. The valve will remain closed until impounded water has cleared to excessive sediment. The sedimentation basin will be modeled with the valve closed, therefore discharges up to the spillway were zero. The secondary outlet structure is a trapezoidal spillway located at elevation is 727.0, has a length of 25' and side slopes of 5 horizontal to 1 vertical.

Sediment Basin B

The primary outlet structure consists of a perforated standpipe with perforations beginning at elevation 656.5 (Normal Water Level). The standpipe is connected to a 24" culvert which is fitted with a valve. The valve will remain closed until impounded water has cleared to excessive sediment. The sedimentation basin will be modeled with the valve closed, therefore discharges up to the spillway were zero. The secondary outlet structure is a trapezoidal spillway located at elevation is 670.5, has a length of 30' and side slopes of 5 horizontal to 1 vertical.

Sediment Basin C

The primary outlet structure consists of a perforated standpipe with perforations beginning at elevation 662.5 (Normal Water Level). The standpipe is connected to a 24" culvert which is fitted with a valve. The valve will remain closed until impounded water has cleared to excessive sediment. The sedimentation basin will be modeled with the valve closed, therefore discharges up to the spillway

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Client: Clinton Landfill, Inc.
Project: Clinton Landfill No. 3
Proj. #: 128017
Calculated By: LJC Date: 10/5/07
Checked By: JPV Date: 10/5/07

TITLE: ORIFICE DISCHARGE CALCULATIONS

---

were zero. The secondary outlet structure is a trapezoidal spillway located at elevation is 670.6, has a length of 30' and side slopes of 5 horizontal to 1 vertical.

Assumptions

Equation 1 is used to calculate flow through the 4' x 4' drop box, which acts like a weir.

Equation 1

$$Q = CL(h - h_0)^{3/2}$$

Where:
Q = Flow, cfs
C = weir coefficient = 3.3 (unitless)
h = water elevation, feet
h_0 = weir elevation, feet
L = weir length perpendicular to flow

Spillways act as broadcrest weirs. For spillway calculations, the average weir length perpendicular to flow is used. The average weir length for trapezoidal spillways is equal to the average between the bottom spillway width and the top width of the water surface. For a spillway with 5V:1H sideslopes, the top of water width is equal to the base width of the spillway plus 10 times the height of the water elevation above the invert elevation.

$$L_{ave} = L + 5(h - h_0)$$

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Client: Clinton Landfill, Inc.
Project: Clinton Landfill No. 3
Proj. #: 128017
Calculated By: LJC Date: 10/5/07
Checked By: JPV Date: 10/5/07

TITLE: ORIFICE DISCHARGE CALCULATIONS

Rewriting Equation No. 1 for a spillway with 5H:1V sideslopes yields equation no. 2.

Equation No. 2

$$Q = C[L + 5(h - h_0)](h - h_0)^{3/2}$$

Where:
- Q = Flow, cfs
- C = weir coefficient = 3.3 (unitless)
- h = water elevation, feet
- h_0 = weir elevation, feet
- L = base width of the spillway

Calculations

The attached spreadsheet summarizes the discharge over the spillway for Sediment Basin A, Sediment Basin B and Sediment Basin C.

Results

The discharges for various elevations were entered into the HEC-HMS model. Results of the model indicate that the spillways are sufficiently sized to covey water from the detention basins with at least 1 foot of freeboard during the 100-year, 24-hour storm event. Refer to Calculation Sheet "Hydrologic Model Analyses," and HEC-HMS output files for a summary of peak discharge rates and basin elevations. Also refer to Section 4, "Stormwater Management Plan" for a detailed discussion.

SPILLWAY DISCHARGE CALCULATION FOR DETENTION BASIN OUTLET STRUCTURES
CLINTON LANDFILL NO. 3
SEDIMENT BASIN A

Spillway Bottom Width (ft):	25.0
Spillway Sideslopes:	5H:1V
Spillway Elevation (ft):	727.0
Spillway (Broadcrest Weir) Coefficient:	3.1

Elevations (ft)	Spillway Weir Flow[3] (cfs)
727.00	0.000
727.50	30.140
728.00	93.000
728.50	185.090
729.00	306.884
729.50	459.518
730.00	644.323

Notes:

[3]Weir flow equation for Spillway:

Q=(weir coefficient)*(spillway base width + 5*(elev-spillway elev)*(elev-spillway elev)^1.5

SPILLWAY DISCHARGE CALCULATION FOR DETENTION BASIN OUTLET STRUCTURES
CLINTON LANDFILL NO. 3
SEDIMENT BASIN B

Spillway Bottom Width (ft):	30.0
Spillway Sideslopes:	5H:1V
Spillway Elevation (ft):	670.5
Spillway (Broadcrest Weir) Coefficient:	3.1

Elevations (ft)	Spillway Weir Flow[3] (cfs)
670.50	0.000
671.00	35.621
671.50	108.500
672.00	213.565
672.50	350.725
673.00	520.788
673.50	724.863

Notes:
[3]Weir flow equation for Spillway:
Q=(weir coefficient)*(spillway base width + 5*(elev-spillway elev)*(elev-spillway elev)^1.5

SPILLWAY DISCHARGE CALCULATION FOR DETENTION BASIN OUTLET STRUCTURES
CLINTON LANDFILL NO. 3
SEDIMENT BASIN C

Spillway Bottom Width (ft):	30.0
Spillway Sideslopes:	5H:1V
Spillway Elevation (ft):	670.6
Spillway (Broadcrest Weir) Coefficient:	3.1

Elevations (ft)	Spillway Weir Flow[3] (cfs)
670.60	0.000
671.00	25.096
671.50	91.316
672.00	190.001
672.50	320.693
673.00	484.092
673.50	681.269

Notes:
[3]Weir flow equation for Spillway:
Q=(weir coefficient)*(spillway base width + 5*(elev-spillway elev)*(elev-spillway elev)^1.5

Hydrology and Floodplain Analysis

Philip B. Bedient
RICE UNIVERSITY

Wayne C. Huber
UNIVERSITY OF FLORIDA

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where

Q_i = inflow (cfs),
Q = outflow (cfs),
V = storage (ft^3),
t = time (s).

The inflow $Q_i(t)$ may consist of upstream flows or rainfall or both and is assumed to be known. A second equation is thus needed to solve for the two unknowns, $Q(t)$ and $V(t)$; Muskingum and detention basin routing were shown for this purpose in Chapter 4. An additional alternative is to use the relationship

$$Q = KV^b, \tag{6.13}$$

where K and b are power function parameters that may be fit by regression techniques or through physical relationships. For example, outflow by a weir or orifice or by Manning's equation lends itself naturally to a power function, especially if depth $h(t)$ is used as the dependent variable instead of $V(t)$ by the relationship

$$dV/dt = A(h)\frac{dh}{dt}, \tag{6.14}$$

where

A = surface area and is a function of depth h.

Then a weir outflow can be represented as

$$Q = C_w L_w (h - h_0)^{1.5}, \tag{6.15}$$

where

L_w = weir length (perpendicular to flow),
h_o = weir crest elevation,
C_w = weir coefficient.

The weir coefficient is dimensional and depends on several factors, especially the weir geometry (Daugherty et al., 1985). Common values for horizontal weirs perpendicular to the flow direction are $C_w = 3.33\ ft^{0.5}/s$ for U.S. customary units and $C_w = 1.84\ m^{0.5}/s$ for metric units.

An orifice would be included as

$$Q = C_d A_o \sqrt{2g(h - h_o)}, \tag{6.16}$$

where

C_d = discharge coefficient,
A_o = area of orifice,
h_o = elevation of orifice centerline.

Submerged culverts often behave as orifices with discharge coefficients ranging from 0.62 for a sharp-edged entrance to nearly 1.0 for a well-rounded entrance (Daugherty et al., 1985). Apart from their universal presence near highways, culverts are widely used as outlets from detention ponds in urban areas.

Finally, Manning's equation can be used as the second relationship between storage and outflow. For a wide rectangular channel (as for overland flow) the hydraulic radius is equal to the depth, and Manning's equation has the form

$$Q = W(k_m/n)(h - DS)^{5/3}S^{1/2}, \tag{6.17}$$

where

W = width of (overland) flow,
n = Manning's roughness,
DS = depression storage (depth),
S = slope.

(The constant k_m was discussed in conjunction with Eq. 6.4.) The relationship (6.17) can be coupled with the continuity equation for generation of overland flow, as shown in Example 6.8.

EXAMPLE 6.8

NONLINEAR RESERVOIR MODEL FOR OVERLAND FLOW

Derive a method for generation of overland flow from rainfall by coupling the continuity equation, Eq. (6.12), with Manning's equation, Eq. (6.17).

SOLUTION

Let inflow to the "reservoir" equal the product of rainfall excess i_e and catchment area A. Using U.S. customary units, Manning's equation can be substituted into the continuity equation, yielding

$$i_eA - W(1.49/n)(h - DS)^{5/3}S^{1/2} = A\frac{dh}{dt},$$

in which the surface area A is assumed to be constant. Dividing by the area gives

$$i_e + WCON(h - DS)^{5/3} = \frac{dh}{dt}, \tag{6.18}$$

where

$$WCON \equiv -\frac{1.49\ WS^{1/2}}{An} \tag{6.19}$$

2. Select the desired cross-sectional shape of your channel in the Channel Type section of the dialog.
3. Enter the appropriate geometric attributes for that channel shape in English units.
4. Select the Enter Depth option if you want to calculate the flow. Select the Enter Flow option if you want to calculate depth. Then enter the depth/flow accordingly.
5. Select the Calculate button in the lower portion of the dialog. You will notice that flow/depth is displayed as well as the other channel properties. Figure 4 is an example of computing flow for a trapezoidal channel.
6. Select OK or Cancel to exit the dialog.

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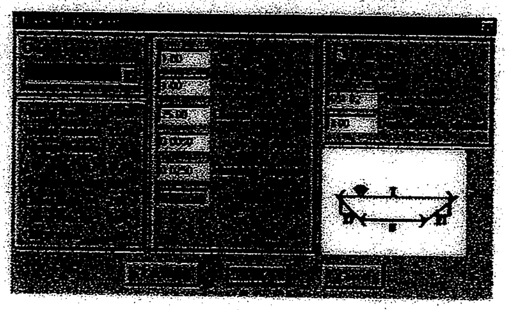
Figure 4 Channel Calculator dialog box for a trapezoidal channel



Weir Calculator

The Weir Calculator can compute head or flow over a weir. If you enter the head, it will compute the flow. If you enter the flow, it will compute the head necessary to obtain that flow. If a hydrograph has been computed from one of the models, the peak flow from that hydrograph will automatically be entered in the flow field. You may change this value, of course.

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Weir Equation

The Weir Calculator uses the standard equation for computing flow over a weir.

$$Q = C_w L h^{3/2}$$

Where:

Q - flow in cfs
Cw - weir coefficient
L - length of the weir in feet
h - head in feet

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Supported Weir Types

There are six predefined weir types included in this calculator. Upon selecting any of these weirs, the appropriate weir coefficient will automatically be entered in the Cw field. There is also a user-defined weir option. For this option you can specify your own weir coefficient. For all of the options you will have to enter the weir length.

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Weir Types	Cw
* Broad-crested	3.1 *
Cipolletti	3.367
V-notch 90 degrees	2.5
V-notch 60 degrees	1.443
V-notch 45 degrees	1.035
V-notch 22.5 degrees	0.497
User-defined weir	User specified

Using the Weir Calculator

1. Select Weirs from the Calculators menu in the Tree module.
2. Select the desired weir in the Weir Type section of the dialog box.
3. Enter the Weir Length (and Weir Coefficient, if applicable) in the appropriate field.
4. Select the Calculate Flow option if you want to calculate the flow, or the Calculate Head option if you want to calculate the head. Then enter the Head/Weir flow accordingly.
5. Select the Calculate button. You will notice that the calculated head/flow appears. Your dialog should look similar to Figure 5.
6. Select OK or Cancel to exit the dialog.

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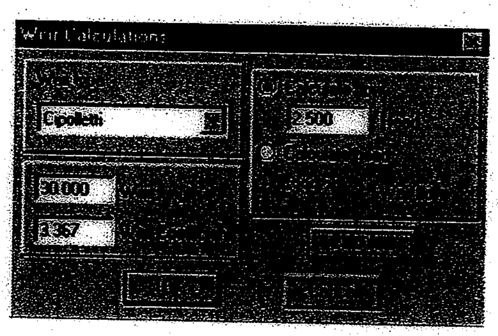
Figure 5 Weir Calculator dialog box



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HEC-HMS MODEL ANALYSIS

Shaw®

Shaw® Shaw Environmental, Inc.

Client: Clinton Landfill, Inc.

Project: Clinton Landfill No. 3

Proj. #: 128017

Calculated By: LJC Date: 9/19/07

Checked By: JPV Date: 9/20/07

TITLE: HYDROLOGIC MODELING ANALYSES

Problem Statement

Determine the stormwater runoff rates and quantities for the final conditions for the proposed Clinton Landfill. Additionally, determine if the proposed stormwater detention basins are adequately sized to handle the 100-year, 24-hour storm event.

Given

The stormwater runoff was calculated using the HEC-HMS computer program. This program was developed and distributed by the U.S. Army Corps of Engineers. The program can be downloaded from the following website: http://www.hec.usace.army.mil/software/hec-hms/hechms-hechms.html

Assumptions

Various parameters, such as rainfall, drainage area, curve number, SCS lag time, and discharge and storage volume of the stormwater detention basins are entered into the program. Calculations to determine these parameters are described in previous portions of this Appendix. Additional information is also available in Section 4 of this application. The following tables summarize the basin design parameters entered into the model. (See attached tables)

The following parameters were entered into HEC-HMS to determine if the basins are properly sized to handle the 100-year, 1-hour and 24-hour storm and determine the peak discharge rates.

Design Input Parameters for Sediment Basin A		
Elevation (feet MSL)	Area at Elevation (acres)	Total Outflow (cfs)
722.00	5.49	0.00
724.00	6.04	0.00
726.00	6.59	0.00
727.00	6.86	0.00
727.5	N/A	30.14
728.0	7.14	93.00
730.0	7.72	644.323

Shaw® Shaw Environmental, Inc.

Client: Clinton Landfill, Inc.
Project: Clinton Landfill No. 3
Proj. #: 128017
Calculated By: LJC Date: 9/19/07
Checked By: JPV Date: 9/20/07

TITLE: HYDROLOGIC MODELING ANALYSES

Design Input Parameters for Sediment Basin B		
Elevation (feet MSL)	Area at Elevation (acres)	Total Outflow (cfs)
656.50	1.17	0.000
658.00	1.32	0.000
660.00	1.48	0.000
662.00	1.64	0.000
664.00	1.81	0.000
666.00	1.99	0.000
668.00	2.17	0.000
670.00	2.36	0.000
670.50	N/A	0.000
671.00	N/A	35.621
672.00	2.56	213.650
673.00	2.66	520.788

Shaw® Shaw Environmental, Inc.

Client: Clinton Landfill, Inc.
Project: Clinton Landfill No. 3
Proj. #: 128017
Calculated By: LJC Date: 9/19/07
Checked By: JPV Date: 9/20/07

TITLE: HYDROLOGIC MODELING ANALYSES

Design Input Parameters for Sediment Basin C		
Elevation (feet MSL)	Area at Elevation (acres)	Total Outflow (cfs)
662.50	2.4500	0.000
664.00	2.6100	0.000
666.00	2.8600	0.000
668.00	3.1200	0.000
670.00	3.4000	0.000
670.60	N/A	0.000
671.00	3.60	25.096
672.00	3.73	190.001
673.00	3.86	484.092

Calculations

The final conditions were analyzed for the 1-hour and 24-hour storm events for the 100-year frequency and the 24-hour duration for the 25-year frequency.

Results

Results of the HEC-HMS computer models are summarized in the following tables. The computer output files are also attached.

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Client: Clinton Landfill, Inc.
Project: Clinton Landfill No. 3
Proj. #: 128017
Calculated By: LJC Date: 9/19/07
Checked By: JPV Date: 9/20/07

TITLE: HYDROLOGIC MODELING ANALYSES

HEC-HMS Results Discharge for the 100-year storm events (cfs)		
Location	**Duration**	
Scenario	**1-hour**	**24-hour**
Sediment Basin A		
Subarea 5	45.8	11.3
Subarea 6	25.0	5.8
Subarea 7a	32.5	8.1
Subarea 7b	29.7	7.4
Subarea 7c	21.7	5.2
Subarea 9	43.5	10.6
Sediment Basin B		
Subarea 1a	39.3	9.8
Subarea 1b	25.6	6.3
Subarea 2	71.6	17.6
Subarea 3	17.1	3.6
Subarea 4	16.1	3.5
Subarea 14	16.6	3.9
Subarea 17	8.3	1.6
Sediment Basin C		
Subarea 10	45.4	10.7
Subarea 11	52.3	12.3
Subarea 12a	7.1	1.4
Subarea 12b	17.5	3.7
Subarea 13	27.0	5.9
Subarea 15	27.1	6.0

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Client: Clinton Landfill, Inc.
Project: Clinton Landfill No. 3
Proj. #: 128017
Calculated By: LJC Date: 9/19/07
Checked By: JPV Date: 9/20/07

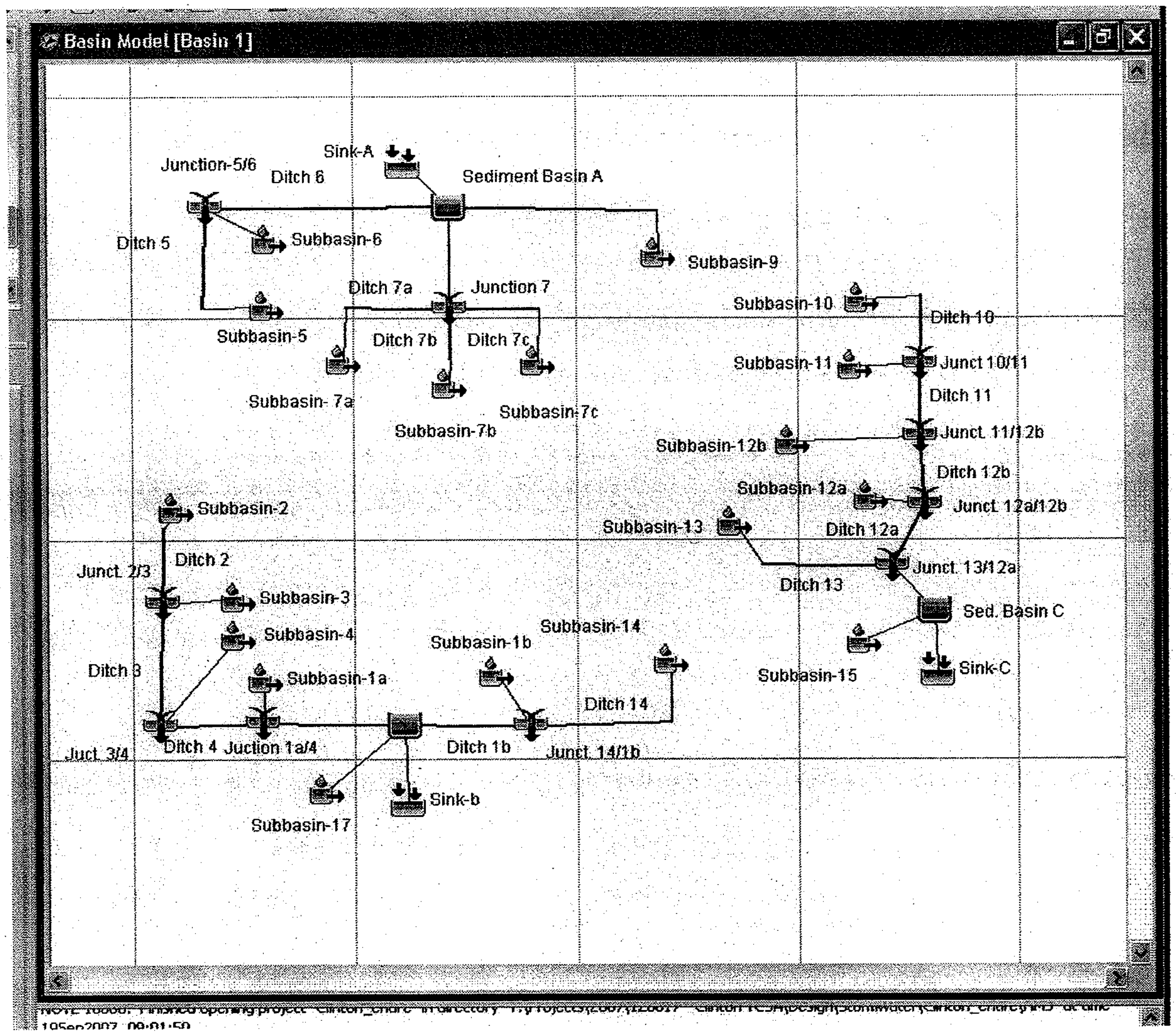
TITLE: HYDROLOGIC MODELING ANALYSES

Stormwater Detention Basin Design Hydrologic Results

Location	100-yr Maximum Inflow (cfs)		100-yr Maximum Outflow (cfs)		100-yr Maximum Elevation (ft)		Top of Basin (ft)	25-yr Maximum Elevation (ft)	Spillway Elevation (ft)
	1-hour	24-hour	1-hour	24-hour	1-hour	24-hour			
Sediment Basin A	196.5	48.3	0.0	0.0	723.8	726.9	731.0	725.6	727.0
Sediment Basin B	184.5	46.0	0.0	11.2	663.4	670.7	674.0	668.6	670.5
Sediment Basin C	168.9	39.9	0.0	7.9	665.8	670.7	674.0	668.8	670.6

Conclusion

Based on the HEC-HMS output results, the basins are properly sized to convey the 100-year, 24-hour storm event and retain the 25-year, 24-hour storm event.


Basin Model [Basin 1]
Sink-A
Junction-5/6
Ditch 6
Sediment Basin A
Ditch 5
Subbasin-6
Subbasin-9
Ditch 7a
Junction 7
Subbasin-10
Ditch 10
Subbasin-5
Ditch 7b
Ditch 7c
Subbasin-11
Junct 10/11
Subbasin- 7a
Ditch 11
Subbasin-7c
Subbasin-7b
Subbasin-12b
Junct. 11/12b
Ditch 12b
Subbasin-12a
Junct. 12a/12b
Subbasin-2
Subbasin-13
Ditch 12a
Ditch 2
Junct. 2/3
Junct. 13/12a
Ditch 13
Subbasin-3
Sed. Basin C
Subbasin-14
Subbasin-4
Subbasin-1b
Ditch 3
Subbasin-1a
Subbasin-15
Sink-C
Ditch 14
Ditch 4
Juction 1a/4
Ditch 1b
Junct. 14/1b
Juct. 3/4
Sink-b
Subbasin-17

Project: Clinton Entire - Closed Val Simulation Run: 25-yr, 24-hr

Start of Run: 01Jan2007, 00:00 Basin Model: Basin 1
End of Run: 05Jan2007, 00:00 Meteorologic Model: 25-yr, 24-hr
Compute Time: 08Oct2007, 10:47:41 Control Specifications: 24-HR

Volume Units: IN

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Ditch 10	0.0244	7.8	01Jan2007, 15:20	3.67
Ditch 11	0.0525	16.7	01Jan2007, 15:20	3.67
Ditch 12a	0.0642	20.4	01Jan2007, 15:20	3.67
Ditch 12b	0.0609	19.3	01Jan2007, 15:20	3.67
Ditch 13	0.0134	4.3	01Jan2007, 15:20	3.67
Ditch 14	0.0088	2.8	01Jan2007, 15:20	3.67
Ditch 1a	0.0785	24.9	01Jan2007, 15:20	3.67
Ditch 1b	0.0233	7.4	01Jan2007, 15:20	3.67
Ditch 2	0.0402	12.8	01Jan2007, 15:20	3.67
Ditch 3	0.0483	15.3	01Jan2007, 15:20	3.67
Ditch 4	0.0562	17.8	01Jan2007, 15:20	3.67
Ditch 5	0.0257	8.2	01Jan2007, 15:20	3.67
Ditch 6	0.0390	12.4	01Jan2007, 15:20	3.67
Ditch 7a	0.0184	5.8	01Jan2007, 15:20	3.67
Ditch 7b	0.0168	5.3	01Jan2007, 15:20	3.67
Ditch 7c	0.0119	3.8	01Jan2007, 15:20	3.67
Ditch 9	0.0243	7.7	01Jan2007, 15:20	3.67
Juct. 3/4	0.0562	17.8	01Jan2007, 15:20	3.67
Juction 1a/4	0.0785	24.9	01Jan2007, 15:20	3.67
Junct. 11/12b	0.0609	19.4	01Jan2007, 15:20	3.67
Junct. 12a/12b	0.0642	20.4	01Jan2007, 15:20	3.67
Junct. 13/12a	0.0776	24.6	01Jan2007, 15:20	3.67
Junct. 14/1b	0.0233	7.4	01Jan2007, 15:20	3.67
Junct. 2/3	0.0483	15.3	01Jan2007, 15:20	3.67
Junct 10/11	0.0525	16.7	01Jan2007, 15:20	3.67

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Junction-5/6	0.0390	12.4	01Jan2007, 15:20	3.67
Junction 7	0.0471	15.0	01Jan2007, 15:20	3.67
Sed. Basin B	0.1054	0.0	01Jan2007, 00:00	0.00
Sed. Basin C	0.0912	0.0	01Jan2007, 00:00	0.00
Sediment BasinA	0.1104	0.0	01Jan2007, 00:00	0.00
Sink-A	0.1104	0.0	01Jan2007, 00:00	0.00
Sink-b	0.1054	0.0	01Jan2007, 00:00	0.00
Sink-C	0.0912	0.0	01Jan2007, 00:00	0.00
Subbasin-10	0.0244	7.8	01Jan2007, 15:20	3.66
Subbasin-11	0.0281	8.9	01Jan2007, 15:20	3.66
Subbasin-12a	0.0033	1.1	01Jan2007, 15:20	3.66
Subbasin-12b	0.0084	2.7	01Jan2007, 15:20	3.66
Subbasin-13	0.0134	4.3	01Jan2007, 15:20	3.66
Subbasin-14	0.0088	2.8	01Jan2007, 15:20	3.66
Subbasin-15	0.0136	4.3	01Jan2007, 15:20	3.66
Subbasin-17	0.0036	1.1	01Jan2007, 15:20	3.66
Subbasin-1a	0.0223	7.1	01Jan2007, 15:20	3.66
Subbasin-1b	0.0145	4.6	01Jan2007, 15:20	3.66
Subbasin-2	0.0402	12.8	01Jan2007, 15:20	3.66
Subbasin-3	0.0081	2.6	01Jan2007, 15:20	3.66
Subbasin-4	0.0079	2.5	01Jan2007, 15:20	3.66
Subbasin-5	0.0257	8.2	01Jan2007, 15:20	3.66
Subbasin-6	0.0133	4.2	01Jan2007, 15:20	3.66
Subbasin- 7a	0.0184	5.9	01Jan2007, 15:20	3.66
Subbasin-7b	0.0168	5.3	01Jan2007, 15:20	3.66
Subbasin-7c	0.0119	3.8	01Jan2007, 15:20	3.66
Subbasin-9	0.0243	7.7	01Jan2007, 15:20	3.66

Project :	Clinton Entire - Closed Val	Simulation Run :	25-yr, 24-hr	Reservoir:	Sediment Basin A

Start of Run :	01Jan2007, 00:00	Basin Model :	Basin 1
End of Run :	05Jan2007, 00:00	Meteorologic Model :	25-yr, 24-hr
Compute Time :	08Oct2007, 10:47:41	Control Specifications :	24-HR

Volume Units : IN

Computed Results

Peak Inflow :	35.0 (CFS)	**Date/Time of Peak Inflow :**	01Jan2007, 15:20
Peak Outflow :	0.0 (CFS)	**Date/Time of Peak Outflow :**	01Jan2007, 00:00
Total Inflow :	3.67 (IN)	**Peak Storage :**	21.6 (AC-FT)
Total Outflow :	0.00 (IN)	**Peak Elevation :**	725.6 (FT)

Project :	Clinton Entire - Closed Val	Simulation Run :	25-yr, 24-hr	Reservoir:	Sed. Basin B

Start of Run :	01Jan2007, 00:00	Basin Model :	Basin 1
End of Run :	05Jan2007, 00:00	Meteorologic Model :	25-yr, 24-hr
Compute Time :	08Oct2007, 10:47:41	Control Specifications :	24-HR

Volume Units : IN

Computed Results

Peak Inflow :	33.4 (CFS)	Date/Time of Peak Inflow :	01Jan2007, 15:20
Peak Outflow :	0.0 (CFS)	Date/Time of Peak Outflow :	01Jan2007, 00:00
Total Inflow :	3.67 (IN)	Peak Storage :	20.6 (AC-FT)
Total Outflow :	0.00 (IN)	Peak Elevation :	668.6 (FT)

Project :	Clinton Entire - Closed Val	Simulation Run :	25-yr, 24-hr	Reservoir:	Sed. Basin C

Start of Run :	01Jan2007, 00:00	Basin Model :	Basin 1
End of Run :	05Jan2007, 00:00	Meteorologic Model :	25-yr, 24-hr
Compute Time :	08Oct2007, 10:47:41	Control Specifications :	24-HR

Volume Units : IN

Computed Results

Peak Inflow :	29.0 (CFS)	**Date/Time of Peak Inflow :**	01Jan2007, 15:20
Peak Outflow :	0.0 (CFS)	**Date/Time of Peak Outflow :**	01Jan2007, 00:00
Total Inflow :	3.67 (IN)	**Peak Storage :**	17.8 (AC-FT)
Total Outflow :	0.00 (IN)	**Peak Elevation :**	668.8 (FT)

Project: Clinton Entire - Closed Val Simulation Run: 100-year, 1-hour

Start of Run: 01Jan2007, 00:00 Basin Model: Basin 1
End of Run: 03Jan2007, 01:00 Meteorologic Model: 100-year, 1-hour
Compute Time: 08Oct2007, 10:58:53 Control Specifications: 1-HR

Volume Units: IN

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Ditch 10	0.0244	45.3	01Jan2007, 00:24	1.80
Ditch 11	0.0525	96.2	01Jan2007, 00:24	1.80
Ditch 12a	0.0642	116.2	01Jan2007, 00:27	1.80
Ditch 12b	0.0609	110.8	01Jan2007, 00:27	1.80
Ditch 13	0.0134	26.6	01Jan2007, 00:24	1.80
Ditch 14	0.0088	16.6	01Jan2007, 00:24	1.80
Ditch 1a	0.0785	137.6	01Jan2007, 00:27	1.80
Ditch 1b	0.0233	41.7	01Jan2007, 00:27	1.80
Ditch 2	0.0402	71.5	01Jan2007, 00:27	1.80
Ditch 3	0.0483	85.0	01Jan2007, 00:27	1.80
Ditch 4	0.0562	98.8	01Jan2007, 00:27	1.80
Ditch 5	0.0257	45.7	01Jan2007, 00:27	1.80
Ditch 6	0.0390	69.4	01Jan2007, 00:27	1.80
Ditch 7a	0.0184	32.5	01Jan2007, 00:27	1.80
Ditch 7b	0.0168	29.7	01Jan2007, 00:27	1.80
Ditch 7c	0.0119	21.5	01Jan2007, 00:27	1.80
Ditch 9	0.0243	43.4	01Jan2007, 00:27	1.80
Juct. 3/4	0.0562	99.0	01Jan2007, 00:24	1.80
Juction 1a/4	0.0785	138.1	01Jan2007, 00:27	1.80
Junct. 11/12b	0.0609	112.2	01Jan2007, 00:24	1.80
Junct. 12a/12b	0.0642	116.6	01Jan2007, 00:24	1.80
Junct. 13/12a	0.0776	142.7	01Jan2007, 00:24	1.80
Junct. 14/1b	0.0233	42.0	01Jan2007, 00:24	1.80
Junct. 2/3	0.0483	85.0	01Jan2007, 00:27	1.80
Junct 10/11	0.0525	97.6	01Jan2007, 00:24	1.80

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Junction-5/6	0.0390	69.7	01Jan2007, 00:27	1.80
Junction 7	0.0471	83.7	01Jan2007, 00:27	1.80
Sed. Basin B	0.1054	0.0	01Jan2007, 00:00	0.00
Sed. Basin C	0.0912	0.0	01Jan2007, 00:00	0.00
Sediment Basin A	0.1104	0.0	01Jan2007, 00:00	0.00
Sink-A	0.1104	0.0	01Jan2007, 00:00	0.00
Sink-b	0.1054	0.0	01Jan2007, 00:00	0.00
Sink-C	0.0912	0.0	01Jan2007, 00:00	0.00
Subbasin-10	0.0244	45.4	01Jan2007, 00:24	1.80
Subbasin-11	0.0281	52.3	01Jan2007, 00:24	1.80
Subbasin-12a	0.0033	7.1	01Jan2007, 00:18	1.80
Subbasin-12b	0.0084	17.5	01Jan2007, 00:18	1.80
Subbasin-13	0.0134	27.0	01Jan2007, 00:21	1.80
Subbasin-14	0.0088	16.6	01Jan2007, 00:24	1.80
Subbasin-15	0.0136	27.1	01Jan2007, 00:21	1.80
Subbasin-17	0.0036	8.3	01Jan2007, 00:15	1.80
Subbasin-1a	0.0223	39.3	01Jan2007, 00:27	1.80
Subbasin-1b	0.0145	25.6	01Jan2007, 00:27	1.80
Subbasin-2	0.0402	71.6	01Jan2007, 00:24	1.80
Subbasin-3	0.0081	17.1	01Jan2007, 00:18	1.80
Subbasin-4	0.0079	16.1	01Jan2007, 00:21	1.80
Subbasin-5	0.0257	45.8	01Jan2007, 00:24	1.80
Subbasin-6	0.0133	25.0	01Jan2007, 00:24	1.80
Subbasin- 7a	0.0184	32.5	01Jan2007, 00:27	1.80
Subbasin-7b	0.0168	29.7	01Jan2007, 00:27	1.80
Subbasin-7c	0.0119	21.7	01Jan2007, 00:24	1.80
Subbasin-9	0.0243	43.5	01Jan2007, 00:24	1.80

Project :	Clinton Entire - Closed Val	Simulation Run :	100-year, 1-hour	Reservoir:	Sediment Basin A

Start of Run :	01Jan2007, 00:00	Basin Model :	Basin 1
End of Run :	03Jan2007, 01:00	Meteorologic Model :	100-year, 1-hour
Compute Time :	08Oct2007, 10:58:53	Control Specifications :	1-HR

Volume Units : IN

Computed Results

Peak Inflow :	196.5 (CFS)	Date/Time of Peak Inflow :	01Jan2007, 00:27
Peak Outflow :	0.0 (CFS)	Date/Time of Peak Outflow :	01Jan2007, 00:00
Total Inflow :	1.80 (IN)	Peak Storage :	10.6 (AC-FT)
Total Outflow :	0.00 (IN)	Peak Elevation :	723.8 (FT)

Project :	Clinton Entire - Closed Val	Simulation Run :	100-year, 1-hour	Reservoir:	Sed. Basin B

Start of Run :	01Jan2007, 00:00	Basin Model :	Basin 1
End of Run :	03Jan2007, 01:00	Meteorologic Model :	100-year, 1-hour
Compute Time :	08Oct2007, 10:58:53	Control Specifications :	1-HR

Volume Units : IN

Computed Results

Peak Inflow :	184.5 (CFS)	Date/Time of Peak Inflow :	01Jan2007, 00:27
Peak Outflow :	0.0 (CFS)	Date/Time of Peak Outflow :	01Jan2007, 00:00
Total Inflow :	1.80 (IN)	Peak Storage :	10.1 (AC-FT)
Total Outflow :	0.00 (IN)	Peak Elevation :	663.4 (FT)

Project :	Clinton Entire - Closed Val	Simulation Run :	100-year, 1-hour	Reservoir:	Sed. Basin C

Start of Run :	01Jan2007, 00:00	Basin Model :	Basin 1
End of Run :	03Jan2007, 01:00	Meteorologic Model :	100-year, 1-hour
Compute Time :	08Oct2007, 10:58:53	Control Specifications :	1-HR

Volume Units : IN

Computed Results

Peak Inflow :	168.9 (CFS)	Date/Time of Peak Inflow :	01Jan2007, 00:24
Peak Outflow :	0.0 (CFS)	Date/Time of Peak Outflow :	01Jan2007, 00:00
Total Inflow :	1.80 (IN)	Peak Storage :	8.8 (AC-FT)
Total Outflow :	0.00 (IN)	Peak Elevation :	665.8 (FT)

Project: Clinton Entire - Closed Val Simulation Run: 100-year, 24-hour

Start of Run: 01Jan2007, 00:00 Basin Model: Basin 1
End of Run: 05Jan2007, 00:00 Meteorologic Model: 100-year, 24-hour
Compute Time: 08Oct2007, 10:55:07 Control Specifications: 24-HR

Volume Units: IN

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Ditch 10	0.0244	10.7	01Jan2007, 15:20	5.18
Ditch 11	0.0525	23.0	01Jan2007, 15:20	5.18
Ditch 12a	0.0642	28.1	01Jan2007, 15:20	5.18
Ditch 12b	0.0609	26.6	01Jan2007, 15:20	5.18
Ditch 13	0.0134	5.9	01Jan2007, 15:20	5.18
Ditch 14	0.0088	3.9	01Jan2007, 15:20	5.18
Ditch 1a	0.0785	34.3	01Jan2007, 15:20	5.18
Ditch 1b	0.0233	10.2	01Jan2007, 15:20	5.18
Ditch 2	0.0402	17.6	01Jan2007, 15:20	5.18
Ditch 3	0.0483	21.1	01Jan2007, 15:20	5.18
Ditch 4	0.0562	24.5	01Jan2007, 15:20	5.18
Ditch 5	0.0257	11.2	01Jan2007, 15:20	5.18
Ditch 6	0.0390	17.0	01Jan2007, 15:20	5.18
Ditch 7a	0.0184	8.0	01Jan2007, 15:20	5.18
Ditch 7b	0.0168	7.3	01Jan2007, 15:20	5.18
Ditch 7c	0.0119	5.2	01Jan2007, 15:20	5.18
Ditch 9	0.0243	10.6	01Jan2007, 15:20	5.18
Juct. 3/4	0.0562	24.6	01Jan2007, 15:20	5.18
Juction 1a/4	0.0785	34.3	01Jan2007, 15:20	5.18
Junct. 11/12b	0.0609	26.7	01Jan2007, 15:20	5.18
Junct. 12a/12b	0.0642	28.1	01Jan2007, 15:20	5.18
Junct. 13/12a	0.0776	33.9	01Jan2007, 15:20	5.18
Junct. 14/1b	0.0233	10.2	01Jan2007, 15:20	5.18
Junct. 2/3	0.0483	21.1	01Jan2007, 15:20	5.18
Junct 10/11	0.0525	23.0	01Jan2007, 15:20	5.18

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Junction-5/6	0.0390	17.1	01Jan2007, 15:20	5.18
Junction 7	0.0471	20.6	01Jan2007, 15:20	5.18
Sed. Basin B	0.1054	11.2	01Jan2007, 21:20	0.75
Sed. Basin C	0.0912	7.9	02Jan2007, 00:00	0.28
Sediment Basin A	0.1104	0.0	01Jan2007, 00:00	0.00
Sink-A	0.1104	0.0	01Jan2007, 00:00	0.00
Sink-b	0.1054	11.2	01Jan2007, 21:20	0.75
Sink-C	0.0912	7.9	02Jan2007, 00:00	0.28
Subbasin-10	0.0244	10.7	01Jan2007, 15:20	5.18
Subbasin-11	0.0281	12.3	01Jan2007, 15:20	5.18
Subbasin-12a	0.0033	1.4	01Jan2007, 15:20	5.18
Subbasin-12b	0.0084	3.7	01Jan2007, 15:20	5.18
Subbasin-13	0.0134	5.9	01Jan2007, 15:20	5.18
Subbasin-14	0.0088	3.9	01Jan2007, 15:20	5.18
Subbasin-15	0.0136	6.0	01Jan2007, 15:20	5.18
Subbasin-17	0.0036	1.6	01Jan2007, 15:20	5.18
Subbasin-1a	0.0223	9.8	01Jan2007, 15:20	5.18
Subbasin-1b	0.0145	6.3	01Jan2007, 15:20	5.18
Subbasin-2	0.0402	17.6	01Jan2007, 15:20	5.18
Subbasin-3	0.0081	3.6	01Jan2007, 15:20	5.18
Subbasin-4	0.0079	3.5	01Jan2007, 15:20	5.18
Subbasin-5	0.0257	11.3	01Jan2007, 15:20	5.18
Subbasin-6	0.0133	5.8	01Jan2007, 15:20	5.18
Subbasin- 7a	0.0184	8.1	01Jan2007, 15:20	5.18
Subbasin-7b	0.0168	7.4	01Jan2007, 15:20	5.18
Subbasin-7c	0.0119	5.2	01Jan2007, 15:20	5.18
Subbasin-9	0.0243	10.6	01Jan2007, 15:20	5.18

Project :	Clinton Entire - Closed Val	Simulation Run :	100-year, 24-hour	Reservoir:	Sediment Basin A

Start of Run :	01Jan2007, 00:00	Basin Model :	Basin 1
End of Run :	05Jan2007, 00:00	Meteorologic Model :	100-year, 24-hour
Compute Time :	08Oct2007, 10:55:07	Control Specifications :	24-HR

Volume Units : IN

Computed Results

Peak Inflow :	48.3 (CFS)	Date/Time of Peak Inflow :	01Jan2007, 15:20
Peak Outflow :	0.0 (CFS)	Date/Time of Peak Outflow :	01Jan2007, 00:00
Total Inflow :	5.18 (IN)	Peak Storage :	30.5 (AC-FT)
Total Outflow :	0.00 (IN)	Peak Elevation :	726.9 (FT)

Project :	Clinton Entire - Closed Val	Simulation Run :	100-year, 24-hour	Reservoir:	Sed. Basin B

Start of Run :	01Jan2007, 00:00	Basin Model :	Basin 1
End of Run :	05Jan2007, 00:00	Meteorologic Model :	100-year, 24-hour
Compute Time :	08Oct2007, 10:55:07	Control Specifications :	24-HR

Volume Units : IN

Computed Results

Peak Inflow :	46.0 (CFS)	Date/Time of Peak Inflow :	01Jan2007, 15:20
Peak Outflow :	11.2 (CFS)	Date/Time of Peak Outflow :	01Jan2007, 21:20
Total Inflow :	5.18 (IN)	Peak Storage :	25.3 (AC-FT)
Total Outflow :	0.75 (IN)	Peak Elevation :	670.7 (FT)

Project :	Clinton Entire - Closed Val	Simulation Run :	100-year, 24-hour	Reservoir:	Sed. Basin C

Start of Run :	01Jan2007, 00:00	Basin Model :	Basin 1
End of Run :	05Jan2007, 00:00	Meteorologic Model :	100-year, 24-hour
Compute Time :	08Oct2007, 10:55:07	Control Specifications :	24-HR

Volume Units : IN

Computed Results

Peak Inflow :	39.9 (CFS)	Date/Time of Peak Inflow :	01Jan2007, 15:20
Peak Outflow :	7.9 (CFS)	Date/Time of Peak Outflow :	02Jan2007, 00:00
Total Inflow :	5.18 (IN)	Peak Storage :	24.3 (AC-FT)
Total Outflow :	0.28 (IN)	Peak Elevation :	670.7 (FT)

DITCH SIZE

Shaw®

Shaw® Shaw Environmental, Inc.

Client: Clinton Landfill, Inc.

Project: Clinton Landfill No. 3

Proj. #: 128017

Calculated By: LJC Date: 9/21/07

Checked By: JPV Date: 9/24/07

TITLE: DITCH SIZE

Problem Statement

Determine the size of all perimeter ditches to adequately handle the peak flow from the 100-year, 1-hour storm event.

Given

The following table summarizes the peak flows from the 100-year, 1-hour storm event that were determined using HEC-HMS computer program and the drainage areas shown on Drawing No. D21. (Note the SCS Lag Time was conservatively calculated without the terraces and downslopes).

Shaw® Shaw Environmental, Inc.

Client: Clinton Landfill, Inc.

Project: Clinton Landfill No. 3

Proj. #: 128017

Calculated By: LJC Date: 9/21/07

Checked By: JPV Date: 9/24/07

TITLE: DITCH SIZE

Design Parameters for Perimeter Ditches				
Ditch	*Q_{peak} (cfs)*	*Sideslopes*	*Channel Slope*	*Channel Depth (feet)*
1a	137.6	2H:1V	.0035	3
1b	41.7	2H:1V	.0051	6.7
2	71.5	2H:1V	.0084	3
3	85.0	2H:1V	.05	3
4	98.8	2H:1V	.0035	3
5	45.7	2H:1V	.005	3
6	69.4	2H:1V	.0065	4.4
7a	32.5	2H:1V	.005	2
7b	29.7	2H:1V	.0051	3
7c	21.5	2H:1V	.0032	3.4
9	43.4	2H:1V	.0187	3
10	45.3	2H:1V	.0351	3
11	96.2	2H:1V	.0039	3
12a	116.2	2H:1V	.0653	3
12b	110.8	2H:1V	.003	3
13	26.6	2H:1V	.003	1.5
14	16.6	2H:1V	.0113	1.5

Shaw® Shaw Environmental, Inc.

Client:	Clinton Landfill, Inc.
Project:	Clinton Landfill No. 3
Proj. #:	128017
Calculated By: LJC	Date: 9/21/07
Checked By: JPV	Date: 9/24/07

TITLE: DITCH SIZE

Assumptions

- ❑ The Manning's roughness coefficient was assumed to be 0.030 for grass lined channels.

Calculations

Calculations were performed using the computer program, Flowmaster, by Haestad Methods. The program uses Manning's equation.

$$V = (1.49/n)R^{2/3}S^{1/2}$$

where:

V = mean velocity, ft/sec
n = Manning's roughness coefficient
R = hydraulic radius, ft
S = slope, ft/ft

Manning's n, peak flow, sideslope, and channel slope were entered into the program and the program solves for depth and velocity. As stated above, Manning's n was varied to determine the critical depth and critical velocity. The Flowmaster output files, which includes all input parameters, are attached.

Results

The Flowmaster results are summarized in the following table. Based on the results, all ditches are adequately sized to handle the peak 100-year, 1-hour storm event and velocities are lower than the recommended values to minimize scour and erosion. Additional erosion protection methods, such as: turf reinforced mats, rock check dams, straw bales will be used for any ditches with velocities over 5 ft/sec.

Shaw® Shaw Environmental, Inc.

Client: Clinton Landfill, Inc.

Project: Clinton Landfill No. 3

Proj. #: 128017

Calculated By: LJC Date: 9/21/07

Checked By: JPV Date: 9/24/07

TITLE: DITCH SIZE

Perimeter Ditches Summary Table				
Ditch	*Q_{peak} (cfs)*	*Channel Depth (feet)*	*Flow Depth (ft)*	*Velocity (ft/sec)*
1a	137.6	3	2.79	4.25
1b	41.7	6.7	1.36	3.50
2	71.5	3	1.59	4.88
3	85.0	3	1.08	9.65
4	98.8	3	2.37	3.89
5	45.7	3	1.44	3.57
6	69.4	4.4	1.68	4.42
7a	32.5	2	1.73	3.43
7b	29.7	3	1.65	3.38
7c	21.5	3.4	1.59	2.62
9	43.4	3	0.98	5.59
10	45.3	3	0.84	7.04
11	96.2	3	2.27	4.02
12a	116.2	3	1.19	11.64
12b	110.8	3	2.60	3.79
13	26.6	1.5	1.23	2.54
14	16.6	1.5	0.65	3.47

Ditch 1a
Worksheet for Trapezoidal Channel

Project Description	
Project File	t:\projects\2007\128017 - clinton tcsa\design\stormwater\clinton_entire\existing.fm2
Worksheet	Ditch 1a
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.003500	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	6.00	ft
Discharge	137.60	cfs

Results		
Depth	2.79	ft
Flow Area	32.34	ft²
Wetted Perimeter	18.49	ft
Top Width	17.17	ft
Critical Depth	2.02	ft
Critical Slope	0.012679	ft/ft
Velocity	4.25	ft/s
Velocity Head	0.28	ft
Specific Energy	3.07	ft
Froude Number	0.55	
Flow is subcritical.		

Ditch 1b
Worksheet for Trapezoidal Channel

Project Description	
Project File	t:\projects\2007\128017 - clinton tcsa\design\stormwater\clinton_entire\existing.fm2
Worksheet	Ditch 1b
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.005100	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	6.00	ft
Discharge	41.70	cfs

Results		
Depth	1.36	ft
Flow Area	11.91	ft²
Wetted Perimeter	12.10	ft
Top Width	11.46	ft
Critical Depth	1.02	ft
Critical Slope	0.014964	ft/ft
Velocity	3.50	ft/s
Velocity Head	0.19	ft
Specific Energy	1.56	ft
Froude Number	0.61	
Flow is subcritical.		

Ditch 2
Worksheet for Trapezoidal Channel

Project Description	
Project File	t:\projects\2007\128017 - clinton tcsa\design\stormwater\clinton_entire\existing.fm2
Worksheet	Ditch 2
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.008400	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	6.00	ft
Discharge	71.50	cfs

Results		
Depth	1.59	ft
Flow Area	14.64	ft²
Wetted Perimeter	13.13	ft
Top Width	12.38	ft
Critical Depth	1.39	ft
Critical Slope	0.013854	ft/ft
Velocity	4.88	ft/s
Velocity Head	0.37	ft
Specific Energy	1.96	ft
Froude Number	0.79	
Flow is subcritical.		

Ditch 3
Worksheet for Trapezoidal Channel

Project Description	
Project File	t:\projects\2007\128017 - clinton tcsa\design\stormwater\clinton_entire\existing.fm2
Worksheet	Ditch 3
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.050000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	6.00	ft
Discharge	85.00	cfs

Results		
Depth	1.08	ft
Flow Area	8.81	ft^2
Wetted Perimeter	10.83	ft
Top Width	10.32	ft
Critical Depth	1.54	ft
Critical Slope	0.013527	ft/ft
Velocity	9.65	ft/s
Velocity Head	1.45	ft
Specific Energy	2.53	ft
Froude Number	1.84	
Flow is supercritical.		

Ditch 4
Worksheet for Trapezoidal Channel

Project Description	
Project File	t:\projects\2007\128017 - clinton tcsa\design\stormwater\clinton_entire\existing.fm2
Worksheet	Ditch 4
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.003500	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	6.00	ft
Discharge	98.80	cfs

Results		
Depth	2.37	ft
Flow Area	25.38	ft^2
Wetted Perimeter	16.58	ft
Top Width	15.46	ft
Critical Depth	1.68	ft
Critical Slope	0.013253	ft/ft
Velocity	3.89	ft/s
Velocity Head	0.24	ft
Specific Energy	2.60	ft
Froude Number	0.54	
Flow is subcritical.		

Ditch 5
Worksheet for Trapezoidal Channel

Project Description	
Project File	t:\projects\2007\128017 - clinton tcsa\design\stormwater\clinton_entire\existing.fm2
Worksheet	Ditch 5
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.005000 ft/ft	
Left Side Slope	2.000000 H : V	
Right Side Slope	2.000000 H : V	
Bottom Width	6.00	ft
Discharge	45.70	cfs

Results		
Depth	1.44	ft
Flow Area	12.80	ft^2
Wetted Perimeter	12.45	ft
Top Width	11.77	ft
Critical Depth	1.07	ft
Critical Slope	0.014764 ft/ft	
Velocity	3.57	ft/s
Velocity Head	0.20	ft
Specific Energy	1.64	ft
Froude Number	0.60	
Flow is subcritical.		

Ditch 6
Worksheet for Trapezoidal Channel

Project Description	
Project File	t:\projects\2007\128017 - clinton tcsa\design\stormwater\clinton_entire\existing.fm2
Worksheet	Ditch 6
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.006500	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	6.00	ft
Discharge	69.40	cfs

Results		
Depth	1.68	ft
Flow Area	15.71	ft^2
Wetted Perimeter	13.51	ft
Top Width	12.72	ft
Critical Depth	1.37	ft
Critical Slope	0.013911	ft/ft
Velocity	4.42	ft/s
Velocity Head	0.30	ft
Specific Energy	1.98	ft
Froude Number	0.70	
Flow is subcritical.		

Ditch 7a
Worksheet for Trapezoidal Channel

Project Description	
Project File	t:\projects\2007\128017 - clinton tcsa\design\stormwater\clinton_entire\existing.fm2
Worksheet	Ditch 7a
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.005000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	2.00	ft
Discharge	32.50	cfs

Results		
Depth	1.73	ft
Flow Area	9.46	ft^2
Wetted Perimeter	9.75	ft
Top Width	8.93	ft
Critical Depth	1.33	ft
Critical Slope	0.015461	ft/ft
Velocity	3.43	ft/s
Velocity Head	0.18	ft
Specific Energy	1.92	ft
Froude Number	0.59	
Flow is subcritical.		

Ditch 7b

Worksheet for Trapezoidal Channel

Project Description	
Project File	t:\projects\2007\128017 - clinton tcsa\design\stormwater\clinton_entire\existing.fm2
Worksheet	Ditch 7b
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.005100	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	2.00	ft
Discharge	29.70	cfs

Results		
Depth	1.65	ft
Flow Area	8.78	ft²
Wetted Perimeter	9.40	ft
Top Width	8.62	ft
Critical Depth	1.27	ft
Critical Slope	0.015639	ft/ft
Velocity	3.38	ft/s
Velocity Head	0.18	ft
Specific Energy	1.83	ft
Froude Number	0.59	
Flow is subcritical.		

Ditch 7c
Worksheet for Trapezoidal Channel

Project Description	
Project File	t:\projects\2007\128017 - clinton tcsa\design\stormwater\clinton_entire\existing.fm2
Worksheet	Ditch 7c
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.003200	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	2.00	ft
Discharge	21.50	cfs

Results		
Depth	1.59	ft
Flow Area	8.21	ft^2
Wetted Perimeter	9.10	ft
Top Width	8.35	ft
Critical Depth	1.08	ft
Critical Slope	0.016295	ft/ft
Velocity	2.62	ft/s
Velocity Head	0.11	ft
Specific Energy	1.69	ft
Froude Number	0.47	
Flow is subcritical.		

Ditch 9
Worksheet for Trapezoidal Channel

Project Description	
Project File	t:\projects\2007\128017 - clinton tcsa\design\stormwater\clinton_entire\existing.fm2
Worksheet	Ditch 9
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.018700	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	6.00	ft
Discharge	43.40	cfs

Results		
Depth	0.98	ft
Flow Area	7.77	ft^2
Wetted Perimeter	10.37	ft
Top Width	9.91	ft
Critical Depth	1.04	ft
Critical Slope	0.014877	ft/ft
Velocity	5.59	ft/s
Velocity Head	0.49	ft
Specific Energy	1.46	ft
Froude Number	1.11	
Flow is supercritical.		

Ditch 10
Worksheet for Trapezoidal Channel

Project Description	
Project File	t:\projects\2007\128017 - clinton tcsa\design\stormwater\clinton_entire\existing.fm2
Worksheet	Ditch 10
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.035100	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	6.00	ft
Discharge	45.30	cfs

Results		
Depth	0.84	ft
Flow Area	6.44	ft^2
Wetted Perimeter	9.75	ft
Top Width	9.35	ft
Critical Depth	1.07	ft
Critical Slope	0.014784	ft/ft
Velocity	7.04	ft/s
Velocity Head	0.77	ft
Specific Energy	1.61	ft
Froude Number	1.50	
Flow is supercritical.		

Ditch 11
Worksheet for Trapezoidal Channel

Project Description	
Project File	t:\projects\2007\128017 - clinton tcsa\design\stormwater\clinton_entire\existing.fm2
Worksheet	Ditch 11
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.003900	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	6.00	ft
Discharge	96.20	cfs

Results		
Depth	2.27	ft
Flow Area	23.93	ft^2
Wetted Perimeter	16.15	ft
Top Width	15.08	ft
Critical Depth	1.65	ft
Critical Slope	0.013301	ft/ft
Velocity	4.02	ft/s
Velocity Head	0.25	ft
Specific Energy	2.52	ft
Froude Number	0.56	
Flow is subcritical.		

Ditch 12a
Worksheet for Trapezoidal Channel

Project Description	
Project File	t:\projects\2007\128017 - clinton tcsa\design\stormwater\clinton_entire\existing.fm2
Worksheet	Ditch 12a
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.065300	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	6.00	ft
Discharge	116.20	cfs

Results		
Depth	1.19	ft
Flow Area	9.99	ft²
Wetted Perimeter	11.33	ft
Top Width	10.77	ft
Critical Depth	1.84	ft
Critical Slope	0.012967	ft/ft
Velocity	11.64	ft/s
Velocity Head	2.10	ft
Specific Energy	3.30	ft
Froude Number	2.13	
Flow is supercritical.		

Ditch 12b
Worksheet for Trapezoidal Channel

Project Description	
Project File	t:\projects\2007\128017 - clinton tcsa\design\stormwater\clinton_entire\existing.fm2
Worksheet	Ditch 12b
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.003000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	6.00	ft
Discharge	110.80	cfs

Results		
Depth	2.60	ft
Flow Area	29.20	ft^2
Wetted Perimeter	17.65	ft
Top Width	16.42	ft
Critical Depth	1.79	ft
Critical Slope	0.013050	ft/ft
Velocity	3.79	ft/s
Velocity Head	0.22	ft
Specific Energy	2.83	ft
Froude Number	0.50	
Flow is subcritical.		

Ditch 13
Worksheet for Trapezoidal Channel

Project Description	
Project File	t:\projects\2007\128017 - clinton tcsa\design\stormwater\clinton_entire\existing.fm2
Worksheet	Ditch 13
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.003000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	6.00	ft
Discharge	26.60	cfs

Results		
Depth	1.23	ft
Flow Area	10.46	ft^2
Wetted Perimeter	11.52	ft
Top Width	10.94	ft
Critical Depth	0.77	ft
Critical Slope	0.016016	ft/ft
Velocity	2.54	ft/s
Velocity Head	0.10	ft
Specific Energy	1.34	ft
Froude Number	0.46	
Flow is subcritical.		

Ditch 14
Worksheet for Trapezoidal Channel

Project Description	
Project File	t:\projects\2007\128017 - clinton tcsa\design\stormwater\clinton_entire\existing.fm2
Worksheet	Ditch 14
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.011300	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	6.00	ft
Discharge	16.60	cfs

Results		
Depth	0.65	ft
Flow Area	4.78	ft²
Wetted Perimeter	8.93	ft
Top Width	8.62	ft
Critical Depth	0.58	ft
Critical Slope	0.017269	ft/ft
Velocity	3.47	ft/s
Velocity Head	0.19	ft
Specific Energy	0.84	ft
Froude Number	0.82	
Flow is subcritical.		

APPENDIX J.3

NPDES PERMIT

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

1021 NORTH GRAND AVENUE EAST, P.O. BOX 19276, SPRINGFIELD, ILLINOIS 62794-9276
THOMAS V. SKINNER, DIRECTOR

217/782-0610

March 03, 2000

CLINTON LANDFILL INC
POB 9071
PEORIA, IL 61612-9071

Re: FACILITY: CLINTON LANDFILL INC CLINTON
NPDES Permit No: ILR105269
COUNTY: DE WITT

Notice of Coverage Under Construction Storm Water General Permit

Dear NPDES Permittee:

'e have reviewed your application and determined that storm water discharges .ssociated with industrial activity from construction sites are appropriately covered by the attached General NPDES Permit issued by the Agency.

Your discharge is covered by this permit effective as of the date of this letter. The Permit as issued covers application requirements, a storm water pollution prevention plan and reporting requirements.

This letter shows your facility permit number below the construction site name. Please save this number and reference it in all future correspondance. Should you have any questions concerning the Permit, please contact the Permit Section at the above telephone number and address.

Very truly yours,

Thomas G. McSwiggin

Thomas G. McSwiggin, P.E.
Manager, Permit Section
Division of Water Pollution Control

TGM:med:concoverage 3

Enclosure

:c: Records Unit
Region 4

General NPDES Permit No. ILR10

Illinois Environmental Protection Agency
Division of Water Pollution Control
1021 North Grand Avenue East
Post Office Box 19276
Springfield, Illinois 62794-9276
www.epa.state.il.us

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

General NPDES Permit For Storm Water Discharges From Construction Site Activities

Expiration Date: May 31, 2008

Issue Date: May 30, 2003

Effective Date: June 1, 2003

n compliance with the provisions of the Illinois Environmental Protection Act, the Illinois Pollution Control Board Rules and Regulations (35 Ill. Adm. Code, Subtitle C, Chapter I), and the Clean Water Act, and the regulations thereunder the following discharges are authorized by this permit, in accordance with the conditions and attachments herein:

Permit Signed May 30, 2003

Toby Frevert, P.E.
Manager
Division of Water Pollution Control

Part I. COVERAGE UNDER THIS PERMIT

A. Permit Area. The permit covers all areas of the State of Illinois with discharges to any waters of the State.

B. Eligibility.

1. This permit shall authorize all discharges of storm water associated with industrial activity from construction sites that will result in the disturbance of one or more acres total land area, construction sites less than one acre of total land that is part of a larger common plan of development or sale if the larger common plan will ultimately disturb one or more acres total land area or construction sites that are designated by the Agency that have the potential for contribution to a violation of water quality standard or significant contribution of pollutants to waters of the State, occurring after the effective date of this permit (including discharges occurring after the effective date of this permit where the construction activity was initiated before the effective date of this permit), except for discharges identified under paragraph I.B.3 (Limitations on Coverage).

2. This permit may only authorize a storm water discharge associated with industrial activity from a construction site that is mixed with a storm water discharge from an industrial source other than construction, where:

   a. the industrial source other than construction is located on the same site as the construction activity;

   b. storm water discharges associated with industrial activity from the areas of the site where construction activities are occurring are in compliance with the terms of this permit; and

   c. storm water discharges associated with industrial activity from the areas of the site where industrial activity other than construction are occurring (including storm water discharges from dedicated asphalt plants and dedicated concrete plants) are covered by a different NPDES general permit or individual permit authorizing such discharges.

3. **Limitations on Coverage.** The following storm water discharges from construction sites are not authorized by this permit:

   a. storm water discharges associated with industrial activity that originate from the site after construction activities have been completed and the site has undergone final stabilization;

   b. discharges that are mixed with sources of non-storm water other than discharges identified in Part III.A (Prohibition on Non-Storm Water Discharges) of this permit and in compliance with paragraph IV.D.5 (Non-Storm Water Discharges) of this permit;

   c. storm water discharges associated with industrial activity that are subject to an existing NPDES individual or general permit or which are issued a permit in accordance with Part VI.N (Requiring an Individual Permit or an Alternative General Permit) of this permit. Such discharges may be authorized under this permit after an existing permit expires provided the existing permit did not establish numeric limitations for such discharges;

d. storm water discharges from construction sites that the Agency has determined to be or may reasonably be expected to be contributing to a violation of a water quality standard; and

e. Storm water discharges that the Agency, at its discretion, determines are not appropriately authorized or controlled by this general permit.

f. Storm water discharges to any receiving water identified under 35 Ill. Adm. Code 302.105(d)(6).

C. **Authorization.**

1. In order for storm water discharges from construction sites to be authorized to discharge under this general permit a discharger must submit a Notice of Intent (NOI) in accordance with the requirements of Part II below, using an NOI form provided by the Agency, or be covered by a valid Illinois General NPDES Construction Site Activities Permit.

2. Where a new operator (contractor) is selected after the submittal of an NOI under Part II below, a new Notice of Intent (NOI) must be submitted by the owner in accordance with Part II.

3. For projects that have complied with State law on historic preservation and endangered species prior to submittal of the NOI, through coordination with the Illinois Historic Preservation Agency and the Illinois Department of Natural Resources or through fulfillment of the terms of interagency agreements with those agencies, the NOI shall indicate that such compliance has occurred.

Unless notified by the Agency to the contrary, dischargers who submit an NOI in accordance with the requirements of this permit are authorized to discharge storm water from construction sites under the terms and conditions of this permit in 30 days after the date the NOI is post marked.

The Agency may deny coverage under this permit and require submittal of an application for an individual NPDES permit based on a review of the NOI or other information.

Part II. NOTICE OF INTENT REQUIREMENTS

A. **Deadlines for Notification.**

1. To receive authorization under this general permit, a discharge must either be covered by a valid Illinois General NPDES Construction Site Permit, or a completed Notice of Intent (NOI) in accordance with Part VI.G (Signatory Requirements) and the requirements of this part must be submitted prior to the commencement of construction. The NOI must be submitted at least 30 days prior to the commencement of construction.

2. Discharges that are covered by a valid Illinois General NPDES Construction Site Activities Permit as of May 31, 2003 are automatically covered by this permit.

A discharger may submit an NOI in accordance with the requirements of this part after the start of construction. In such instances, the Agency may bring an enforcement action for any discharges of storm water associated with industrial activity from a construction site that have occurred on or after the start of construction.

B. **Failure to Notify.** Dischargers who fail to notify the Agency of their intent to be covered, and discharge storm water associated with construction site activity to Waters of the State without an NPDES permit, are in violation of the Environmental Protection Act and Clean Water Act.

C. **Contents of Notice of Intent.** The Notice of Intent shall be signed in accordance with Part VI.G (Signatory Requirements) of this permit by all of the entities identified in paragraph 2 below and shall include the following information:

1. The mailing address, and location of the construction site for which the notification is submitted. Where a mailing address for the site is not available, the location can be described in terms of the latitude and longitude of the approximate center of the facility to the nearest 15 seconds, or the nearest quarter section (if the section, township and range is provided) that the construction site is located in;

2. The owner's name, address, telephone number, and status as Federal, State, private, public or other entity;

3. The name, address and telephone number of the general contractor(s) that have been identified at the time of the NOI submittal;

4. The name of the receiving water(s), or if the discharge is through a municipal separate storm sewer, the name of the municipal operator of the storm sewer and the ultimate receiving water(s);

5. The number of any NPDES permit for any discharge (including non-storm water discharges) from the site that is currently authorized by an NPDES permit;

6. A yes or no indication of whether the owner or operator has existing quantitative data which describes the concentration of pollutants in storm water discharges (existing data should not be included as part of the NOI); and

7. A brief description of the project, estimated timetable for major activities, estimates of the number of acres of the site on which soil will be disturbed, and a certification that a storm water pollution prevention plan has been or will be prepared for the facility in accordance with Part IV of this permit prior to the start of construction, and such plan provides compliance with local sediment and erosion plans or permits and/or storm water management plans or permits in accordance with paragraph VI.G.1 (Signatory Requirements) of this permit. **(A copy of the plans or permits <u>should not</u> be included with the NOI submission).**

D. **Where to Submit.**

Facilities which discharge storm water associated with construction site activity must use an NOI form provided by the Agency. NOIs must be signed in accordance with Part VI.G (Signatory Requirements) of this permit. NOIs are to be submitted certified mail to the Agency at the following address:

Illinois Environmental Protection Agency
Division of Water Pollution Control
Attention: Permit Section
1021 North Grand Avenue East
Post Office Box 19276
Springfield, Illinois 62794-9276

2. A copy of the letter of notification of coverage or other indication that storm water discharges from the site are covered under an NPDES permit shall be posted at the site in a prominent place for public viewing (such as alongside a building permit).

E. **Additional Notification.** Facilities which are operating under approved local sediment and erosion plans, grading plans, or storm water management plans, in addition to filing copies of the Notice of Intent in accordance with Part D above, shall also submit signed copies of the Notice of Intent to the local agency approving such plans in accordance with the deadlines in Part A above. See Part IV.D.2.d (Approved State or Local Plans).

F. **Notice of Termination.** Where a site has been finally stabilized and all storm water discharges from construction sites that are authorized by this permit are eliminated, the permittee of the facility must submit a completed Notice of Termination that is signed in accordance with Part VI.G (Signatory Requirements) of this permit.

1. The Notice of Termination shall include the following information:

   a. The mailing address, and location of the construction site for which the notification is submitted. Where a mailing address for the site is not available, the location can be described in terms of the latitude and longitude of the approximate center of the facility to the nearest 15 seconds, or the nearest quarter section (if the section, township and range is provided) that the construction site is located in;

   b. The owner's name, address, telephone number, and status as Federal, State, private, public or other entity;

   c. The name, address and telephone number of the general contractor(s); and

   d. The following certification signed in accordance with Part VI.G (Signatory Requirements) of this permit:

   "I certify under penalty of law that all storm water discharges associated with construction site activity from the identified facility that are authorized by NPDES general permit ILR10 have otherwise been eliminated. I understand that by submitting this notice of termination, that I am no longer authorized to discharge storm water associated with construction site activity by the general permit, and that discharging pollutants in storm water associated with construction site activity to Waters of the State is unlawful under the Environmental Protection Act and Clean Water Act where the discharge is not authorized by a NPDES permit. I also understand that the submittal of this notice of termination does not release an operator from liability for any violations of this permit or the Clean Water Act."

   For the purposes of this certification, elimination of storm water discharges associated with industrial activity means that all disturbed soils at the identified facility have been finally stabilized and temporary erosion and sediment control measures have been removed or will be removed at an appropriate time, or that all storm water discharges associated with construction activities from the identified site that are authorized by a NPDES general permit have otherwise been eliminated.

2. All Notices of Termination are to be sent, using the form provided by the Agency, to the address in paragraph II.D.1.

Part III. SPECIAL CONDITIONS, MANAGEMENT PRACTICES, AND OTHER NON-NUMERIC LIMITATIONS

A. **Prohibition on Non-Storm Water Discharges.**

1. Except as provided in paragraph I.B.2 and 2 below, all discharges covered by this permit shall be composed entirely of storm water.

2. a. Except as provided in paragraph b below, discharges of materials other than storm water must be in compliance with a NPDES permit (other than this permit) issued for the discharge.

   b. The following non-storm water discharges may be authorized by this permit provided the non-storm water component of the discharges is in compliance with paragraph IV.D.5 (Non-Storm Water Discharges): discharges from fire fighting activities; fire hydrant flushings; waters used to wash vehicles where detergents are not used; waters used to control dust; potable water sources including uncontaminated waterline flushings; irrigation drainages; routine external building washdown which does not use detergents; pavement washwaters where spills or leaks of toxic or hazardous materials have not occurred (unless all spilled material has been removed) and where detergents are not used; air conditioning condensate; springs; uncontaminated ground water; and foundation or footing drains where flows are not contaminated with process materials such as solvents.

B. Discharges into Receiving Waters With an Approved Total Maximum Daily Load (TMDL):

Discharges to waters for which there is a TMDL allocation for sediment or a parameter that addressed sediment (such as total suspended solids, turbidity, or siltation) are not eligible for coverage under this permit unless you develop and certify a SWPPP that is consistent with the assumptions and requirements in the approved TMDL. To be eligible for coverage under this general permit, operators must incorporate into their SWPPP any conditions applicable to their discharges necessary for consistency with the assumptions and requirements of the TMDL within any timeframes established in the TMDL. If a specific numeric wasteload allocation has been established that would apply to the project's discharges, the operator must incorporate that allocation into its SWPPP and implement necessary steps to meet that allocation.

charges covered by this permit, alone or in combination with other sources, shall not cause or contribute to a violation of any applicable water quality andard.

P~ STORM WATER POLLUTION PREVENTION PLANS

.ın water pollution prevention plan shall be developed for each construction site covered by this permit. Storm water pollution prevention plans shall be prepared in accordance with good engineering practices. The plan shall identify potential sources of pollution which may reasonably be expected to affect the quality of storm water discharges associated with construction site activity from the facility. In addition, the plan shall describe and ensure the implementation of practices which will be used to reduce the pollutants in storm water discharges associated with construction site activity and to assure compliance with the terms and conditions of this permit. Facilities must implement the provisions of the storm water pollution prevention plan required under this part as a condition of this permit.

A. **Deadlines for Plan Preparation and Compliance.**

The plan shall:

1. Be completed prior to the start of the construction to be covered under this permit and updated as appropriate; and

2. Provide for compliance with the terms and schedule of the plan beginning with the initiation of construction activities.

B. **Signature, Plan Review and Notification.**

1. The plan shall be signed in accordance with Part VI.G (Signatory Requirements), and be retained on-site at the facility which generates the storm water discharge in accordance with Part VI.E (Duty to Provide Information) of this permit.

2. Prior to commencement of construction, the permittee shall provide written notification to the Agency of completion of the SWPPP and that said plan is available at the site.

3. The permittee shall make plans available upon request from this Agency or a local agency approving sediment and erosion plans, grading plans, or storm water management plans; or in the case of a storm water discharge associated with industrial activity which discharges through a municipal separate storm sewer system with an NPDES permit, to the municipal operator of the system.

4. The Agency may notify the permittee at any time that the plan does not meet one or more of the minimum requirements of this Part. Such notification shall identify those provisions of the permit which are not being met by the plan, and identify which provisions of the plan requires modifications in order to meet the minimum requirements of this part. Within 7 days from receipt of notification from the Agency, the permittee shall make the required changes to the plan and shall submit to the Agency a written certification that the requested changes have been made. Failure to comply shall terminate authorization under this permit.

5. All storm water pollution prevention plans required under this permit are considered reports that shall be available to the public at any reasonable time upon request. However, the permittee may claim any portion of a storm water pollution prevention plan as confidential in accordance with 40 CFR Part 2.

C. **Keeping Plans Current**. The permittee shall amend the plan whenever there is a change in design, construction, operation, or maintenance, which has a significant effect on the potential for the discharge of pollutants to the Waters of the State and which has not otherwise been addressed in the plan or if the storm water pollution prevention plan proves to be ineffective in eliminating or significantly minimizing pollutants from sources identified under paragraph D.2 below, or in otherwise achieving the general objectives of controlling pollutants in storm water discharges associated with construction site activity. In addition, the plan shall be amended to identify any new contractor and/or subcontractor that will implement a measure of the storm water pollution prevention plan. Amendments to the plan may be reviewed by the Agency in the same manner as Part IV.B above.

D. **Contents of Plan**. The storm water pollution prevention plan shall include the following items:

1. **Site Description**. Each plan shall, provide a description of the following:

   a. A description of the nature of the construction activity;

   b. A description of the intended sequence of major activities which disturb soils for major portions of the site (e.g. grubbing, excavation, grading);

   c. Estimates of the total area of the site and the total area of the site that is expected to be disturbed by excavation, grading, or other activities;

   d. An estimate of the runoff coefficient of the site after construction activities are completed and existing data describing the soil or the quality of any discharge from the site;

   e. A site map indicating drainage patterns and approximate slopes anticipated before and after major grading activities, locations where vehicles enter or exit the site and controls to prevent offsite sediment tracking, areas of soil disturbance, the location of major structural and nonstructural controls identified in the plan, the location of areas where stabilization practices are expected to occur, surface waters (including wetlands), and locations where storm water is discharged to a surface water; and

   f. The name of the receiving water(s) and the ultimate receiving water(s), and areal extent of wetland acreage at the site.

2. **Controls**. Each plan shall include a description of appropriate controls that will be implemented at the construction site. The plan will clearly describe for each major activity identified in paragraph D.1 above, appropriate controls and the timing during the construction process that the controls will be implemented. (For example, perimeter controls for one portion of the site will be installed after the clearing and grubbing necessary for installation of the measure, but before the clearing and grubbing for the remaining portions of the site. Perimeter controls will be actively maintained until final stabilization of those portions of the site upward of the perimeter control. Temporary perimeter controls will be removed after final stabilization). The description of controls shall address as appropriate the following minimum components:

a. **Erosion and Sediment Controls.**

(i) **Stabilization Practices.** A description of interim and permanent stabilization practices, including site-specific scheduling of the implementation of the practices. Site plans should ensure that existing vegetation is preserved where attainable and that disturbed portions of the site are stabilized. Stabilization practices may include: temporary seeding, permanent seeding, mulching, geotextiles, sod stabilization, vegetative buffer strips, protection of trees, preservation of mature vegetation, and other appropriate measures. A record of the dates when major grading activities occur, when construction activities temporarily or permanently cease on a portion of the site, and when stabilization measures are initiated shall be included in the plan. Except as provided in paragraphs (A) and (B) below, stabilization measures shall be initiated as soon as practicable in portions of the site where construction activities have temporarily or permanently ceased, but in no case more than 14 days after the construction activity in that portion of the site has temporarily or permanently ceased.

(A) Where the initiation of stabilization measures by the 14th day after construction activity temporary or permanently cease is precluded by snow cover, stabilization measures shall be initiated as soon as practicable.

(B) Where construction activity will resume on a portion of the site within 21 days from when activities ceased, (e.g. the total time period that construction activity is temporarily ceased is less than 21 days) then stabilization measures do not have to be initiated on that portion of site by the 14th day after construction activity temporarily ceased.

(ii) **Structural Practices.** A description of structural practices to the degree attainable, to divert flows from exposed soils, store flows or otherwise limit runoff and the discharge of pollutants from exposed areas of the site. Such practices may include silt fences, earth dikes, drainage swales, sediment traps, check dams, subsurface drains, pipe slope drains, level spreaders, storm drain inlet protection, rock outlet protection, reinforced soil retaining systems, gabions, and temporary or permanent sediment basins. Structural practices should be placed on upland soils to the degree attainable. The installation of these devices may be subject to Section 404 of the CWA.

(iii) **Best Management Practices for Impaired Waters.** For any site which discharges directly to an impaired water identified in the Agency's 303(d) listing for suspended solids, turbidity, or siltation the storm water pollution prevention plan shall be designed for a storm event equal to or greater than a 25-year 24-hour rainfall event. If required by federal regulations or the Illinois Environmental Protection Agency's Illinois Urban Manual, the storm water pollution prevention plan shall adhere to a more restrictive design criteria.

b. **Storm Water Management.** A description of measures that will be installed during the construction process to control pollutants in storm water discharges that will occur after construction operations have been completed. Structural measures should be placed on upland soils to the degree attainable. The installation of these devices may be subject to Section 404 of the CWA. This permit only addresses the installation of storm water management measures, and not the ultimate operation and maintenance of such structures after the construction activities have been completed and the site has undergone final stabilization. Permittees are responsible for only the installation and maintenance of storm water management measures prior to final stabilization of the site, and are not responsible for maintenance after storm water discharges associated with industrial activity have been eliminated from the site.

(i) Such practices may include: storm water detention structures (including wet ponds); storm water retention structures; flow attenuation by use of open vegetated swales and natural depressions; infiltration of runoff onsite; and sequential systems (which combine several practices). The pollution prevention plan shall include an explanation of the technical basis used to select the practices to control pollution where flows exceed predevelopment levels.

(ii) Velocity dissipation devices shall be placed at discharge locations and along the length of any outfall channel as necessary to provide a non-erosive velocity flow from the structure to a water course so that the natural physical and biological characteristics and functions are maintained and protected (e.g. maintenance of hydrologic conditions, such as the hydroperiod and hydrodynamics present prior to the initiation of construction activities).

(iii) Unless otherwise specified in the Illinois Environmental Protection Agency's Illinois Urban Manual, the storm water pollution prevention plan shall be designed for a storm event equal to or greater than a 25-year 24-hour rainfall event.

c. **Other Controls.**

(i) **Waste Disposal.** No solid materials, including building materials, shall be discharged to Waters of the State, except as authorized by a Section 404 permit.

(ii) The plan shall ensure and demonstrate compliance with applicable State and/or local waste disposal, sanitary sewer or septic system regulations.

d. **Approved State or Local Plans.**

(i) The management practices, controls and other provisions contained in the storm water pollution prevention plan must be at least as protective as the requirements contained in Illinois Environmental Protection Agency's Illinois Urban Manual, 2002. Facilities which discharge storm water associated with construction site activities must include in their storm water pollution prevention plan procedures and requirements specified in applicable sediment and erosion site plans or storm water management plans approved by local officials. Requirements specified in sediment and erosion site plans or site permits or storm water management site plans or site permits approved by local officials that are applicable to protecting surface water resources are, upon submittal of an NOI to be authorized to discharge under this permit, incorporated by reference and are enforceable under this permit even if they are not specifically included in a storm water pollution prevention plan required under this permit. This provision does not apply to provisions of master plans, comprehensive plans, non-enforceable guidelines or technical guidance documents that are not identified in a specific plan or permit that is issued for the construction site.

(ii) Dischargers seeking alternative permit requirements are not authorized by this permit and shall submit an individual permit application in accordance with 40 CFR 122.26 at the address indicated in Part II.D (Where to Submit) of this permit, along with a description of why requirements in approved local plans or permits should not be applicable as a condition of an NPDES permit.

3. **Maintenance**. A description of procedures to maintain in good and effective operating conditions vegetation, erosion and sediment control measures and other protective measures identified in the site plan.

4. **Inspections**. Qualified personnel (provided by the permittee) shall inspect disturbed areas of the construction site that have not been finally stabilized, structural control measures, and locations where vehicles enter or exit the site at least once every seven calendar days and within 24 hours of the end of a storm that is 0.5 inches or greater or equivalent snowfall. Qualified personnel means a person knowledgeable in the principles and practice of erosion and sediment controls, such as a licensed professional engineer or other knowledgeable person who possesses the skills to assess conditions at the construction site that could impact storm water quality and to assess the effectiveness of any sediment and erosion control measures selected to control the quality of storm water discharges from the construction activities.

   a. Disturbed areas and areas used for storage of materials that are exposed to precipitation shall be inspected for evidence of, or the potential for, pollutants entering the drainage system. Erosion and sediment control measures identified in the plan shall be observed to ensure that they are operating correctly. Where discharge locations or points are accessible, they shall be inspected to ascertain whether erosion control measures are effective in preventing significant impacts to receiving waters. Locations where vehicles enter or exit the site shall be inspected for evidence of offsite sediment tracking.

   b. Based on the results of the inspection, the description of potential pollutant sources identified in the plan in accordance with paragraph IV.D.1 (Site Description) of this permit and pollution prevention measures identified in the plan in accordance with paragraph IV.D.2 (Controls) of this permit shall be revised as appropriate as soon as practicable after such inspection. Such modifications shall provide for timely implementation of any changes to the plan within 7 calendar days following the inspection.

   c. A report summarizing the scope of the inspection, name(s) and qualifications of personnel making the inspection, the date(s) of the inspection, major observations relating to the implementation of the storm water pollution prevention plan, and actions taken in accordance with paragraph b above shall be made and retained as part of the storm water pollution prevention plan for at least three years from the date that the permit coverage expires or is terminated. The report shall be signed in accordance with Part VI.G (Signatory Requirements) of this permit.

   d. The permittee shall complete and submit within 5 days an "Incidence of Noncompliance" (ION) report for any violation of the storm water pollution prevention plan observed during an inspection conducted, including those not required by the Plan. Submission shall be on forms provided by the Agency and include specific information on the cause of noncompliance, actions which were taken to prevent any further causes of noncompliance, and a statement detailing any environmental impact which may have resulted from the noncompliance.

   e. All reports of noncompliance shall be signed by a responsible authority as defined in Part VI.G (Signatory Requirements).

   f. All reports of noncompliance shall be mailed to the Agency at the following address:

      Illinois Environmental Protection Agency
      Division of Water Pollution Control
      Compliance Assurance Section
      1021 North Grand Avenue East
      Post Office Box 19276
      Springfield, Illinois 62794-9276

5. **Non-Storm Water Discharges** - Except for flows from fire fighting activities, sources of non-storm water listed in paragraph III.A.2 of this permit that are combined with storm water discharges associated with industrial activity must be identified in the plan. The plan shall identify and insure the implementation of appropriate pollution prevention measures for the non-storm water component(s) of the discharge.

E. **Additional requirements for storm water discharge from industrial activities other than construction, including dedicated asphalt plants, and dedicated concrete plants.** - This permit may only authorize a storm water discharge associated with industrial activity from a construction site that is mixed with a storm water discharge from an industrial source other than construction, where:

1. The industrial source other than construction is located on the same site as the construction activity;

2. Storm water discharges associated with industrial activity from the areas of the site where construction activities are occurring are in compliance with the terms of this permit; and

3. Storm water discharges associated with industrial activity from the areas of the site where industrial activity other than construction are occurring (including storm water discharges from dedicated asphalt plants (other than asphalt emulsion facilities) and dedicated concrete plants) are in compliance with the terms, including applicable NOI or application requirements, of a different NPDES general permit or individual permit authorizing such discharges.

F. **Contractors.**

1. The storm water pollution prevention plan must clearly identify for each measure identified in the plan, the contractor(s) or subcontractor(s) that will implement the measure. All contractors and subcontractors identified in the plan must sign a copy of the certification statement in paragraph 2 below in accordance with Part VI.G (Signatory Requirements) of this permit. All certifications must be included in the storm water pollution prevention plan except for owners that are acting as contractor.

3. **Certification Statement**. All contractors and subcontractors identified in a storm water pollution prevention plan in accordance with paragraph 1 above shall sign a copy of the following certification statement before conducting any professional service at the site identified in the storm water pollution prevention plan:

   "I certify under penalty of law that I understand the terms and conditions of the general National Pollutant Discharge Elimination System (NPDES) permit (ILR10) that authorizes the storm water discharges associated with industrial activity from the construction site identified as part of this certification."

   The certification must include the name and title of the person providing the signature in accordance with Part VI.G of this permit; the name, address and telephone number of the contracting firm; the address (or other identifying description) of the site; and the date the certification is made.

P... RETENTION OF RECORDS

. The permittee shall retain copies of storm water pollution prevention plans and all reports and notices required by this permit, and records of all data used to complete the Notice of Intent to be covered by this permit, for a period of at least three years from the date that the permit coverage expires or is terminated. This period may be extended by request of the Agency at any time.

B. The permittee shall retain a copy of the storm water pollution prevention plan required by this permit at the construction site from the date of project initiation to the date of final stabilization.

Part VI. STANDARD PERMIT CONDITIONS

A. **Duty to Comply.**

The permittee must comply with all conditions of this permit. Any permit noncompliance constitutes a violation of Illinois Environmental Protection Act and the CWA and is grounds for enforcement action; for permit termination, revocation and reissuance, or modification; or for denial of a permit renewal application.

B. **Continuation of the Expired General Permit.** This permit expires five years from the date of issuance. An expired general permit continues in force and effect until a new general permit or an individual permit is issued. Only those facilities authorized to discharge under the expiring general permit are covered by the continued permit.

C. **Need to halt or reduce activity not a defense.** It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

D. **Duty to Mitigate.** The permittee shall take all reasonable steps to minimize or prevent any discharge in violation of this permit which has a reasonable likelihood of adversely affecting human health or the environment.

E. **Duty to Provide Information.** The permittee shall furnish within a reasonable time to the Agency or local agency approving sediment and erosion plans, grading plans, or storm water management plans; or in the case of a storm water discharge associated with industrial activity which discharges through a municipal separate storm sewer system with an NPDES permit, to the municipal operator of the system, any information which is requested to determine compliance with this permit. Upon request, the permittee shall also furnish to the Agency or local agency approving sediment and erosion plans, grading plans, or storm water management plans; or in the case of a storm water discharge associated with industrial activity which discharges through a municipal separate storm sewer system with an NPDES permit, to the municipal operator of the system, copies of records required to be kept by this permit.

F **Other Information.** When the permittee becomes aware that he or she failed to submit any relevant facts or submitted incorrect information in the Notice of Intent or in any other report to the Agency, he or she shall promptly submit such facts or information.

G. **Signatory Requirements.** All Notices of Intent, storm water pollution prevention plans, reports, certifications or information either submitted to the Agency or the operator of a large or medium municipal separate storm sewer system, or that this permit requires be maintained by the permittee, shall be signed.

1. All Notices of Intent shall be signed as follows:

    a. For a corporation: by a responsible corporate officer. For the purpose of this section, a responsible corporate officer means: (1) a president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision-making functions for the corporation; or (2) the manager of one or more manufacturing, production or operating facilities employing more than 250 persons or having gross annual sales or expenditures exceeding $25,000,000 (in second-quarter 1980 dollars) if authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures;

    b. For a partnership or sole proprietorship: by a general partner or the proprietor, respectively; or

    c. For a municipality, State, Federal, or other public agency: by either a principal executive officer or ranking elected official. For purposes of this section, a principal executive officer of a Federal agency includes (1) the chief executive officer of the agency, or (2) a senior executive officer having responsibility for the overall operations of a principal geographic unit of the agency.

2. All reports required by the permit and other information requested by the Agency shall be signed by a person described above or by a duly authorized representative of that person. A person is a duly authorized representative only if:

    a. The authorization is made in writing by a person described above and submitted to the Agency.

    b. The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity, such as the position of manager, operator, superintendent, or position of equivalent responsibility or an individual or position having overall responsibility for environmental matters for the company. (A duly authorized representative may thus be either a named individual or any individual occupying a named position).

    c. **Changes to authorization.** If an authorization under paragraph I.C (Authorization) is no longer accurate because a different individual or position has responsibility for the overall operation of the construction site, a new authorization satisfying the requirements of paragraph I.C must be submitted to the Agency prior to or together with any reports, information, or applications to be signed by an authorized representative.

    d. **Certification.** Any person signing documents under this Part shall make the following certification:

        "I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

'alties for Falsification of Reports. Section 309(c)(4) of the Clean Water Act provides that any person who knowingly makes any false material .ement, representation, or certification in any record or other document submitted or required to be maintained under this permit, including reports of compliance or noncompliance shall, upon conviction, be punished by a fine of not more than $10,000, or by imprisonment for not more than 2 years, or by both. Section 44(j)(4) and (5) of the Environmental Protection Act provides that any person who knowingly makes any false statement, representation, or certification in an application form, or form pertaining to a NPDES permit commits a Class A misdemeanor, and in addition to any other penalties provided by law is subject to a fine not to exceed $10,000 for each day of violation.

I. **Penalties for Falsification of Monitoring Systems**. The CWA provides that any person who falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method required to be maintained under this permit shall, upon conviction, be punished by fines and imprisonment described in Section 309 of the CWA. The Environmental Protection Act provides that any person who knowingly renders inaccurate any monitoring device or record required in connection with any NPDES permit or with any discharge which is subject to the provisions of subsection (f) of Section 12 of the Act commits a Class A misdemeanor, and in addition to any other penalties provided by law is subject to a fine not to exceed $10,000 for each day of violation.

J. **Oil and Hazardous Substance Liability**. Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee is or may be subject under section 311 of the CWA.

K. **Property Rights**. The issuance of this permit does not convey any property rights of any sort, nor any exclusive privileges, nor does it authorize any injury to private property nor any invasion of personal rights, nor any infringement of Federal, State or local laws or regulations.

L. **Severability**. The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit shall not be affected thereby.

M. **Transfers**. This permit is not transferable to any person except after notice to the Agency. The Agency may require the discharger to apply for and obtain an individual NPDES permit as stated in Part I.C (Authorization).

N. **Requiring an Individual Permit or an Alternative General Permit.**

1. The Agency may require any person authorized by this permit to apply for and/or obtain either an individual NPDES permit or an alternative NPDES general permit. Any interested person may petition the Agency to take action under this paragraph. Where the Agency requires a discharger authorized to discharge under this permit to apply for an individual NPDES permit, the Agency shall notify the discharger in writing that a permit application is required. This notification shall include a brief statement of the reasons for this decision, an application form, a statement setting a deadline for the discharger to file the application, and a statement that on the effective date of the individual NPDES permit or the alternative general permit as it applies to the individual permittee, coverage under this general permit shall automatically terminate. Applications shall be submitted to the Agency indicated in Part II.D (Where to Submit) of this permit. The Agency may grant additional time to submit the application upon request of the applicant. If a discharger fails to submit in a timely manner an individual NPDES permit application as required by the Agency under this paragraph, then the applicability of this permit to the individual NPDES permittee is automatically terminated at the end of the day specified by the Agency for application submittal. The Agency may require an individual NPDES permit based on:

   a. information received which indicates the receiving water may be of particular biological significance pursuant to 35 Ill. Adm. Code 302.105(d)(6);

   b. whether the receiving waters are impaired waters for suspended solids, turbidity or siltation as identified by the Agency's 303(d) listing;

   c. size of construction site, proximity of site to the receiving stream, etc.

   The Agency may also require monitoring of any storm water discharge from any site to determine whether an individual permit is required.

2. Any discharger authorized by this permit may request to be excluded from the coverage of this permit by applying for an individual permit. In such cases, the permittee shall submit an individual application in accordance with the requirements of 40 CFR 122.26(c)(1)(ii), with reasons supporting the request, to the Agency at the address indicated in Part II.D (Where to Submit) of this permit. The request may be granted by issuance of any individual permit or an alternative general permit if the reasons cited by the permittee are adequate to support the request.

3. When an individual NPDES permit is issued to a discharger otherwise subject to this permit, or the discharger is authorized to discharge under an alternative NPDES general permit, the applicability of this permit to the individual NPDES permittee is automatically terminated on the effective date of the individual permit or the date of authorization of coverage under the alternative general permit, whichever the case may be. When an individual NPDES permit is denied to a discharger otherwise subject to this permit, or the discharger is denied for coverage under an alternative NPDES general permit, the applicability of this permit to the individual NPDES permittee remains in effect, unless otherwise specified by the Agency.

O. **State/Environmental Laws**. No condition of this permit shall release the permittee from any responsibility or requirements under other environmental statutes or regulations.

P. **Proper Operation and Maintenance**. The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to achieve compliance with the conditions of this permit and with the requirements of storm water pollution prevention plans. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. Proper operation and maintenance requires the operation of backup or auxiliary facilities or similar systems, installed by a permittee only when necessary to achieve compliance with the conditions of the permit.

Q. **Inspection and Entry**. The permittee shall allow the IEPA, or an authorized representative upon presentation of credentials and other documents as may be required by law, to:

Enter upon the permittee's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of this permit;

2. Have access to and copy at reasonable times, any records that must be kept under the conditions of this permit;

3. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this permit; and

4. Sample or monitor at reasonable times, for the purposes of assuring permit compliance or as otherwise authorized by the Clean Water Act, any substances or parameters at any location.

R. **Permit Actions**. This permit may be modified, revoked and reissued, or terminated for cause. The filing of a request by the permittee for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance does not stay any permit condition.

Part VII. REOPENER CLAUSE

A. If there is evidence indicating potential or realized impacts on water quality due to any storm water discharge associated with industrial activity covered by this permit, the discharger may be required to obtain an individual permit or an alternative general permit in accordance with Part I.C (Authorization) of this permit or the permit may be modified to include different limitations and/or requirements.

B. Permit modification or revocation will be conducted according to provisions of 35 Ill. Adm. Code, Subtitle C, Chapter I and the provisions of 40 CFR 122.62, 122.63, 122.64 and 124.5 and any other applicable public participation procedures.

C. The Agency will reopen and modify this permit under the following circumstances:

1. the U.S. EPA amends its regulations concerning public participation;

2. a court of competent jurisdiction binding in the State of Illinois or the 7th Circuit issues an order necessitating a modification of public participation for general permits; or

3. to incorporate federally required modifications to the substantive requirements of this permit.

Part VIII. DEFINITIONS

"Agency" means the Illinois Environmental Protection Agency.

"Best Management Practices" ("BMPs") means schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the United States. BMPs also include treatment requirements, operating procedures, and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

"Commencement of Construction" - The initial disturbance of soils associated with clearing, grading, or excavating activities or other construction activities.

"CWA" means Clean Water Act (formerly referred to as the Federal Water Pollution Control Act or Federal Water Pollution Control Act Amendments of 1972) Pub.L. 92-500, as amended Pub. L. 95-217, Pub. L. 95-576, Pub. L. (96-483 and Pub. L. 97-117, 33 U.S.C. 1251 et.seq.)

"Dedicated portable asphalt plant" - A portable asphalt plant that is located on or contiguous to a construction site and that provides asphalt only to the construction site that the plant is located on or adjacent to. The term dedicated portable asphalt plant does not include facilities that are subject to the asphalt emulsion effluent limitation guideline at 40 CFR 443.

"Dedicated portable concrete plant" - A portable concrete plant that is located on or contiguous to a construction site and that provides concrete only to the construction site that the plant is located on or adjacent to.

"Dedicated sand or gravel operation" - An operation that produces sand and/or gravel for a single construction project.
"Director" means the Director of the Illinois Environmental Protection Agency or an authorized representative.

"Final Stabilization" means that all soil disturbing activities at the site have been completed, and that a uniform perennial vegetative cover with a density of 70% the cover for unpaved areas and areas not covered by permanent structures has been established or equivalent stabilization measures (such as the use of riprap, gabions or geotextiles) have been employed.

"Large and Medium municipal separate storm sewer system" means all municipal separate storm sewers that are either:

(i) Located in an incorporated place (city) with a population of 100,000 or more as determined by the latest Decennial Census by the Bureau of Census (these cities are listed in Appendices F and G of 40 CFR Part 122); or

(ii) Located in the counties with unincorporated urbanized populations of 100,000 or more, except municipal separate storm sewers that are located in the incorporated places, townships or towns within such counties (these counties are listed in Appendices H and I of 40 CFR Part 122); or

(iii) Owned or operated by a municipality other than those described in paragraph (i) or (ii) and that are designated by the Director as part of the large or medium municipal separate storm sewer system.

"NOI" means notice of intent to be covered by this permit (see Part II of this permit.)

"Point Source" means any discernible, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel or other floating craft from which pollutants are or may be discharges. This term does not include return flows from irrigated agriculture or agricultural storm water runoff.

"Runoff coefficient" means the fraction of total rainfall that will appear at the conveyance as runoff.

"Storm Water" means storm water runoff, snow melt runoff, and surface runoff and drainage.

"Storm Water Associated with Industrial Activity" means the discharge from any conveyance which is used for collecting and conveying storm water and ch is directly related to manufacturing, processing or raw materials storage areas at an industrial plant. The term does not include discharges from ities or activities excluded from the NPDES program. For the categories of industries identified in subparagraphs (i) through (x) of this subsection, the term includes, but is not limited to, storm water discharges from industrial plant yards; immediate access roads and rail lines used or traveled by carriers of raw materials, manufactured products, waste material, or by-products used or created by the facility; material handling sites; refuse sites; sites used for the application or disposal of process waste waters (as defined at 40 CFR 401); sites used for the storage and maintenance of material handling equipment; sites used for residual treatment, storage, or disposal; shipping and receiving areas; manufacturing buildings; storage areas (including tank farms) for raw materials, and intermediate and finished products; and areas where industrial activity has taken place in the past and significant materials remain and are exposed to storm water. For the categories of industries identified in subparagraph (xi), the term includes only storm water discharges from all areas listed in the previous sentence (except access roads) where material handling equipment or activities, raw materials, intermediate products, final products, waste materials, by-products, or industrial machinery are exposed to storm water. For the purposes of this paragraph, material handling activities include the: storage, loading and unloading, transportation, or conveyance of any raw material, intermediate product, finished product, by-product or waste product. The term excludes areas located on plant lands separate from the plant's industrial activities, such as office buildings and accompanying parking lots as long as the drainage from the excluded areas is not mixed with storm water drained from the above described areas. Industrial facilities (including industrial facilities that are Federally or municipally owned or operated that meet the description of the facilities listed in this paragraph (i)- (xi)) include those facilities designated under 40 CFR 122.26(a)(1)(v). The following categories of facilities are considered to be engaging in "industrial activity" for purposes of this subsection:

(i) Facilities subject to storm water effluent limitations guidelines, new source performance standards, or toxic pollutant effluent standards under 40 CFR Subchapter N (except facilities with toxic pollutant effluent standards which are exempted under category (xi) of this paragraph);

(ii) Facilities classified as Standard Industrial Classifications 24 (except 2434), 26 (except 265 and 267), 28, 29, 311, 32, 33, 3441, 373;

(iii) Facilities classified as Standard Industrial Classifications 10 through 14 (mineral industry) including active or inactive mining operations (except for areas of coal mining operations meeting the definition of a reclamation area under 40 CFR 434.11(l)) and oil and gas exploration, production, processing, or treatment operations, or transmission facilities that discharge storm water contaminated by contact with or that has come into contact with, any overburden, raw material, intermediate products, finished products, byproducts or waste products located on the site of such operations; inactive mining operations are mining sites that are not being actively mined, but which have an identifiable owner/operator;

(iv) Hazardous waste treatment, storage, or disposal facilities, including those that are operating under interim status or a permit under Subtitle C of RCRA;

(v) Landfills, land application sites, and open dumps that have received any industrial wastes (waste that is received from any of the facilities described under this subsection) including those that are subject to regulation under Subtitle D of RCRA;

(vi) Facilities involved in the recycling of materials, including metal scrapyards, battery reclaimers, salvage yards, and automobile junkyards, including but limited to those classified as Standard Industrial Classification 5015 and 5093;

Steam electric power generating facilities, including coal handling sites;

(viii) Transportation facilities classified as Standard Industrial Classifications 40, 41, 42, 44, and 45 which have vehicle maintenance shops, equipment cleaning operations, or airport deicing operations. Only those portions of the facility that are either involved in vehicle maintenance (including vehicle rehabilitation, mechanical repairs, painting, fueling, and lubrication), equipment cleaning operations, airport deicing operations, or which are otherwise identified under subparagraphs (i)-(vii) or (ix)-(xi) of this subsection are associated with industrial activity;

(ix) Treatment works treating domestic sewage or any other sewage sludge or wastewater treatment device or system, used in the storage treatment, recycling, and reclamation of municipal or domestic sewage, including land dedicated to the disposal of sewage sludge that are located within the confines of the facility, with a design flow of 1.0 mgd or more, or required to have an approved pretreatment program under 40 CFR 403. Not included are farm lands, domestic gardens or lands used for sludge management where sludge is beneficially reused and which are not physically located in the confines of the facility, or areas that are in compliance with 40 CFR 503;

(x) Construction activity including clearing, grading and excavation activities except: operations that result in the disturbance of less than one acre of total land area which are not part of a larger common plan of development or sale unless otherwise designated by the Agency pursuant to **Part I.B.1**.

(xi) Facilities under Standard Industrial Classifications 20, 21, 22, 23, 2434, 25, 265, 267, 27, 283, 31 (except 311), 34 (except 3441), 35, 36, 37 (except 373), 38, 39, 4221-25, (and which are not otherwise included within categories (i)-(x)).

"Waters" mean all accumulations of water, surface and underground, natural, and artificial, public and private, or parts thereof, which are wholly or partially within, flow through, or border upon the State of Illinois, except that sewers and treatment works are not included except as specially mentioned; provided, that nothing herein contained shall authorize the use of natural or otherwise protected waters as sewers or treatment works except that in-stream aeration under Agency permit is allowable.

PDC Technical Services, Inc.

FILE COPY

May 10, 2007

PDC Project No. 91-0118

Mr. Richard Pinneo
Division of Water Pollution Control – Permit Section
Illinois Environmental Protection Agency
1021 North Grand Avenue
P.O. Box 19276
Springfield, Illinois 62702

Re: **Modification to Existing General NPDES Permit No. ILR000312 to Discharge Storm Water Associated with Industrial Activity**
Clinton Landfill, Inc.
DeWitt County

Dear Mr. Pinneo:

On February 25, 2005, Clinton Landfill, Inc. (CLI) submitted to the Agency an application for an Individual NPDES Permit to Discharge Storm Water Associated with Industrial Activity at Clinton Landfill No. 3. That application is still pending and it is our understanding that the individual permit might not be issued by the end of 2007. Therefore, since CLI anticipates operating the landfill by the end of this year, we are submitting a Notice of Intent to revise CLI's existing General NPDES Permit No. ILR000312. General NPDES Permit No. ILR000312 was previously issued to CLI for Clinton Landfill No. 2, which is located adjacent to Clinton Landfill No. 3 (see drawings included with Attachment 1). Construction activities for Clinton Landfill No. 3 are authorized under General NPDES Permit No. ILR105269, which is consistent with the Notice of Intent submitted to the Agency on April 22, 2004.

Industrial activities at Clinton Landfill No. 3 will be essentially identical to those which have historically occurred at Clinton Landfill No. 2, and will include:

- Weighing trucks hauling non-hazardous wastes to the landfill,
- Spreading, grading, compacting, and covering wastes inside the active landfill cell,
- Extracting leachate and either recirculating it back into the landfill via an underground piping system, or storing it in a storage tank,
- Transferring leachate from the storage tank to tanker trucks for transporting to a permitted wastewater treatment facility for treatment and discharge under a separate permit,
- Extracting and controlling landfill gas via a flare and/or gas-to-energy conversion system, and
- Equipment fueling and maintenance.

Industrial equipment that will be exposed to storm water include:

4700 North Sterling Avenue; Peoria, Illinois 61615
P.O. Box 9071, Peoria, Illinois 61612-9071
(309) 676-4893, (Fax) 672-2726

- Earthmoving equipment (e.g. bulldozers, hydraulic excavators, scrapers, dump trucks, compactors, etc.),
- Waste compactor equipment,
- Landfill gas flare station (electric motors, blower, controls, and flare), and
- Above-ground fuel storage tanks.

Additional details are provided in Attachment 1.

Since this application is a modification to an existing permit, it is our understanding that a permit application fee is not required.

We trust that this letter and attachments provide the information needed to modify the existing permit. Please contact Mr. Bill Bicher or the undersigned at 309-676-4893 extensions 217 and 216, respectively, if you have any questions, comments, or if any addition information is required.

Sincerely,

PDC Technical Services, Inc.
Ill. Professional Design Firm 184-001145

George L. Armstrong, P.E.
Vice President – Engineering and Consulting Services

Enclosure: Notice of Intent
Attachment 1

cc: Ron Edwards, Gary Yaste
file copy

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ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

NOTICE OF INTENT (NOI)

FOR

GENERAL PERMIT TO DISCHARGE STORM WATER ASSOCIATED WITH INDUSTRIAL ACTIVITY (EXCLUDING CONSTRUCTION ACTIVITY)

OWNER/OPERATOR INFORMATION

NAME: (LAST / FIRST / MIDDLE INITIAL (OR COMPANY NAME))	Clinton Landfill, Inc.			OWNER TYPE:	private
MAILING ADDRESS:	P.O. Box 9071				
CITY:	Peoria	STATE:	IL	ZIP:	61612
CONTACT PERSON:	Ron Edwards, Vice President	TELEPHONE NUMBER:	AREA CODE 309	NUMBER	676-4893

FACILITY/SITE INFORMATION

SELECT ONE: ☐ NEW SITE ☐ RENEWAL ☑ CHANGE OF INFORMATION TO GENERAL NPDES PERMIT NO.: ILR00 312

FACILITY NAME:	Clinton Landfill, Inc.	OTHER NPDES PERMIT NUMBERS:	ILR1052969		
FACILITY LOCATION:	U.S. Route 51 South	TELEPHONE NUMBER:	AREA CODE 217	NUMBER	935-8028

CITY:	ST:	ZIP:	LATITUDE: DEG.	MIN.	SEC.	LONGITUDE: DEG.	MIN.	SEC.
Clinton	IL	61727	40	06	47	88	57	07

COUNTY:	SECTION:	TOWNSHIP:	RANGE:
DeWitt	10,11,14,15	19N	02E

SIC OR DESIGNATED ACTIVITY CODE(S):	PRIMARY	2ND	3RD	4TH
	4953			

STORM WATER POLLUTION PREVENTION PLAN COMPLETED ☑ YES ☐ NO (IF NO, SEPARATE NOTIFICATION REQUIRED TO AGENCY PRIOR TO COVERAGE LETTER SENT BY AGENCY)

RECEIVING WATER INFORMATION

DOES YOUR STORM WATER DISCHARGE DIRECTLY TO: ☑ WATER OF THE STATE OR ☐ STORM SEWER

OWNER OF STORM SEWER SYSTEM:

NAME OF CLOSEST RECEIVING WATER: Salt Creek

DOES QUANTITATIVE DATA CURRENTLY EXIST WHICH DESCRIBES THE CONCENTRATION OF POLLUTANTS IN THE STORM WATER DISCHARGES? ☑ YES ☐ NO

ADDITIONAL INFORMATION

ATTACH A LIST OF MATERIAL HANDLING ACTIVITIES, RAW MATERIALS, INTERMEDIATE PRODUCTS, FINAL PRODUCTS, WASTE MATERIALS, BY-PRODUCTS OR INDUSTRIAL MACHINERY THAT IS EXPOSED TO STORMWATER.

ATTACH A LIST IF YOU HAVE OTHER INDUSTRIAL ACTIVITIES TAKING PLACE AT YOUR FACILITY NOT COVERED BY THE ABOVE SIC CODES.

FORM 2-F ATTACHED ☐ Yes ☑ No (SEE INSTRUCTIONS)

I certify under penalty of law that this document and all attachments were prepared under my direction and supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage this system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment. In addition, I certify that the provisions of the permit, including the development and implementation of a storm water pollution prevention plan and a monitoring program plan, will be complied with. I also certify that, to the best of my knowledge, the storm water which is discharged from this facility/site does not contain process wastewater, domestic wastewater, or cooling water.

APPLICANT SIGNATURE: [signature] Title: Vice President Date: 5/10/07

MAIL COMPLETED FORM TO:

(DO NOT SUBMIT ADDITIONAL DOCUMENTATION UNLESS REQUESTED)

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
DIVISION OF WATER POLLUTION CONTROL
ATTN: PERMIT SECTION
POST OFFICE BOX 19276
SPRINGFIELD, ILLINOIS 62794-9276
www.epa.state.il.us

FOR OFFICE USE ONLY

LOG:
PERMIT NO. ILR00 ____
DATE:

Information required by this form must be provided to comply with 415 ILCS 5/39 (1996). Failure to do so may prevent this form from being processed and could result in your application being denied. This form has been approved by the Forms Management Center.

IL 532 2103
WPC 622Rev. 4/04

ATTACHMENT No. 1
Application for Permit to Discharge Storm Water Associated with Industrial Activity
Clinton Landfill No. 3

Clinton Landfill No. 3 is a municipal and nonhazardous special waste landfill that is expected to begin operations during 2007. A description of the various site activities, identification of expected significant materials that will be treated, stored or disposed in a manner to allow exposure to storm water, and a description of the storm water controls for each facility area are provided below.

Landfill Areas

The facility location is shown on Drawing NPDES-1; existing site topography is shown on Drawing NPDES-2, Drawing NPDES-3 illustrates the landfill floor; Drawing NPDES-4 illustrates the final cover grades, outfalls that will receive run-off from areas with industrial activities, and drainage areas contributing to each outfall.

Wastes will be transported in covered trucks to the active disposal area within the landfill cell. The waste materials will then be discharged at the active disposal area, graded, and compacted. The waste will be covered at the end of each operating day with at least 6-inches of clean soil or a geotextile specifically designed for landfill cover. The "daily cover" will be thickened to at least 12-inches of clean soil in areas where waste placement will not occur for 60 days or more. Final cover, which includes a geomembrane beneath 3 feet of clean soil, will be placed over the landfill in stages as portions of the landfill have been filled to the maximum grades allowed. The final cover will be vegetated with grass.

The daily, intermediate and final covers ensure that storm water only contacts waste within the active disposal area. The active disposal area will be limited to less than ½ acre within the landfill cell. During wet weather, earth berms constructed of clean soil will be placed along the perimeter of the active disposal area to prevent run-off and to minimize run-on. Contact storm water (i.e. storm water that contacts waste) will be allowed to infiltrate into the landfill. Infiltration water that percolates through the waste will be collected as leachate. Leachate will either be recirculated back into the landfill via underground piping, recirculated into the adjacent Clinton Landfill No. 2, or pumped through buried piping to the underground storage tank (UST) at the Operations Area. Excess leachate that cannot be recirculated will be hauled by tanker truck to a permitted wastewater treatment facility for treatment and discharge. These storm water and leachate management procedures ensure that storm water that contacts waste does not run off the facility.

The landfill will be developed in phases (see Phasing Plan, Drawing NPDES-5). As shown on Drawings NPDES-3 and NPDES-4, the landfill will be surrounded by a perimeter ditch. This ditch will drain storm water to one of three sediment basins as shown. The landfill floor will be founded approximately 20 to 60 feet below the existing ground surface. During all phases of operations, except near the end of the last phase, at least some run-off from the covered landfill will drain to a temporary sump constructed at the bottom of the excavation. Water that collects in the temporary sump will either be allowed to clear, then discharged by pumping, or will be pumped from the temporary sump into one of the three sediment basins.

Approximately the western one-half of Sediment Basin A will be constructed prior to beginning waste placement in Phase 1, and will be used to collect all storm water run-off from Phase 1. The remaining portion of Sediment Basin A will be constructed prior to beginning waste placement in

Phase 2. Run-off from landfill development Phases 1 through 4, and a portion of Phases 5 and 6 will drain into Sediment Basin A. Run-off from a portion of landfill development Phase 5, and from Phases 7, 9, and 11 will drain into Sediment Basin B. Run-off from a portion of landfill development Phase 6, and from Phases 8, 10, and 12 will drain into Sediment Basin C.

The sediment basins are designed with valved primary outlets. Each of the three sediment basins at this facility has sufficient capacity below the emergency spillway to retain all run-off from their contributing drainage area resulting from the 25-year, 24-hour storm, plus sediment storage. The emergency spillways are designed to pass the peak flow from the 100-year storm. Sediment Basin A discharges to Outfall No. 1; Sediment Basin B discharges to Outfall No. 2 and Sediment Basin C discharges to Outfall No. 3. Details of the Sediment Basin A outlet works are shown on Drawing NPDES-6. The outlet works for Sediment Basins B and C are similar to that shown on Drawing NPDES-6.

The sediment basin primary outlet works discharge valve will typically remain closed. The discharge valve will only be opened to drain the sediment basin after water retained in the sediment basin has visually cleared of sediment. The primary outlet works are designed to drain the full basin capacity within 48 hours. The valve will be closed again after the basin is drained.

Sediment that accumulates in the sediment basins will be removed on an as-needed basis. Removed sediment will be used as landfill cover, or will be stockpiled within an area exhibiting sediment controls such as silt fences, filter strips, sediment traps, etc.

Landfill equipment typically will be refueled directly from a tanker truck positioned within the landfill waste boundary. Any fuel spillage would be fully contained by the sediment basins and will be promptly removed and properly disposed.

Shop Area

The Shop Area includes the maintenance building/scale house/office, parking areas, fuel storage, and refueling area. The ground surface at the Shop Area will be either under roof, paved, graveled, or vegetated with grass. Most of the run-off from the Shop Area will discharge into a grassed swale at Outfall No. 4 located northeast of the Shop Area. This grassed swale discharges to an unnamed tributary to Salt Creek.

Fuel (gasoline and diesel fuel) will be stored in double-wall aboveground storage tanks. Any spills or leaks of fuel will be promptly cleaned up and properly disposed.

Operations Area

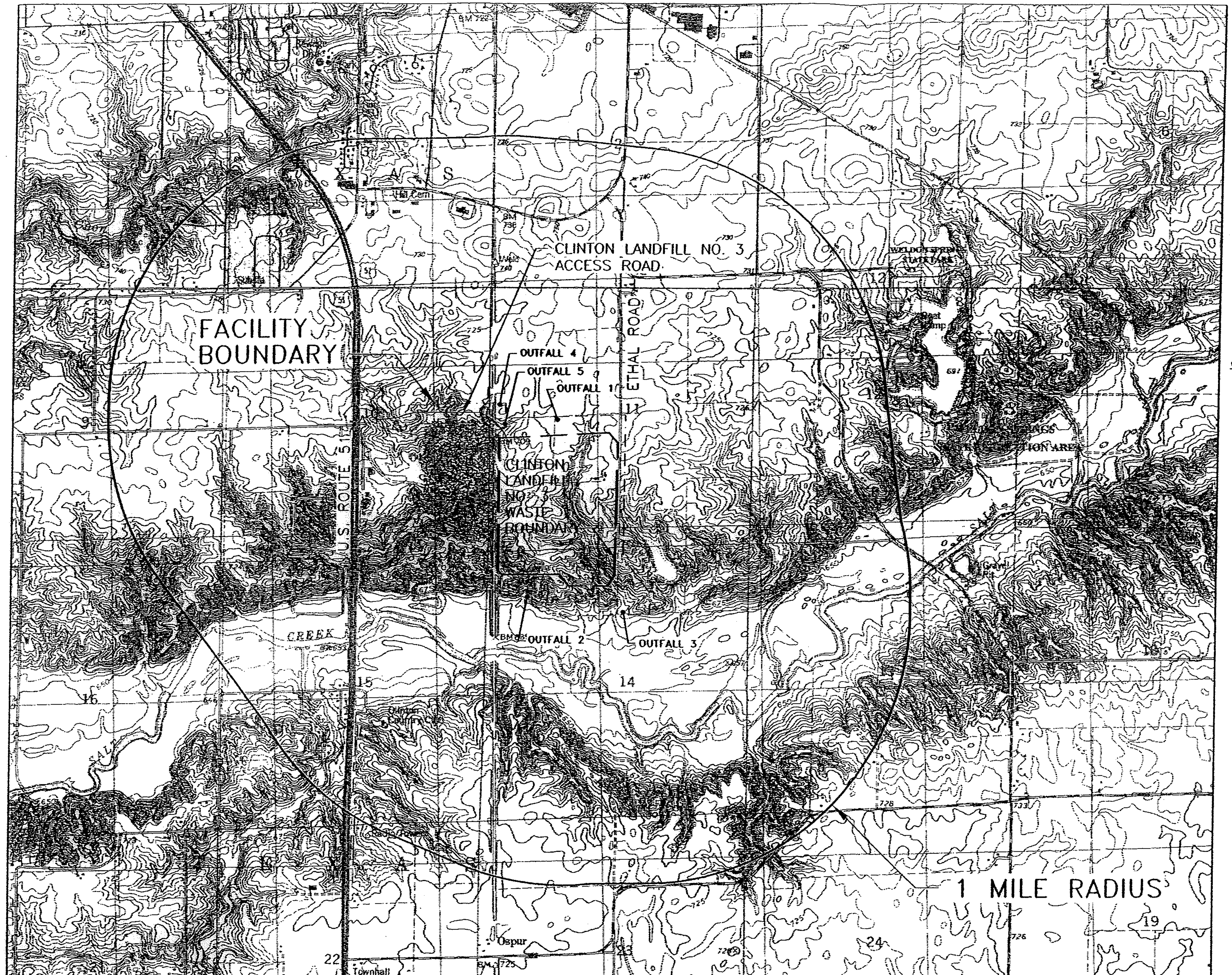
The Operations Area includes the landfill gas flare station and leachate storage/load-out facility. The ground surface at the Operations Area is either paved, graveled, or vegetated with grass. Run-off from the Operations Area except the leachate load-out pad flows into Sediment Basin A and discharges to an unnamed tributary to Salt Creek at Outfall No. 1.

Waste materials will be removed from the landfill equipment prior to moving the equipment from the landfill area for maintenance. The removed waste materials will then be properly disposed in the landfill. Additional cleaning, which might include brushing and pressure washing with clear water (i.e. no detergents) will then be performed on a graveled or paved surface within the Operations Area. Any debris or significant amounts of mud resulting from equipment cleaning will be removed and properly disposed. Equipment washing will be conducted in a manner such as to not cause erosion of the ground surface.

Most equipment maintenance will be conducted inside the maintenance building; however, some maintenance might be performed anywhere within the property. Any spills or leaks of equipment fluids (i.e. oil, grease, fuel, coolant, etc.) will promptly be cleaned up and properly disposed. All virgin and used equipment fluids will be stored inside the maintenance building.

As previously described, excess leachate (which includes condensate that collects in the landfill gas collection system) will be pumped via buried double-wall piping to the UST. Accumulated leachate will be pumped from the UST to a tanker truck for offsite treatment and disposal. The leachate transfer will occur on a concrete containment pad ("Leachate Load-Out Pad"). The containment pad will be fitted with a storm water sump. Two valved buried pipes will be connected to the sump. One pipe, referred to as the leachate return, drains to the UST. The other pipe will be used to discharge clean storm water to Outfall No. 5. Prior to transferring leachate, the storm water valve will be closed and the leachate return valve will be opened to ensure that any spillage drains directly to the UST. All spilled leachate and residues will be removed from the slab and sump prior to reopening the storm water drain valve.

j:\projects\91-118 cli\permit applications\cli #3 sw npdes\form 2f attachment cl no. 3.doc



OUTFALL#	LOCATION	LATITUDE	LONGITUDE
1	SEDBASIN A	N40°07'4.32"	E88°57'3.55"
2	SEDBASIN B	N40°06'29.09"	E88°57'10.68"
3	SEDBASIN C	N40°06'26.11"	E88°56'45.37"
4	MAINTENANCE BUILDING	N40°07'5.7"	E88°57'20.14"
5	LEACHATE LOAD-OUT PAD	N40°07'3.2"	E88°57'20.14"

1000' 0 1000' 2000'
1"=1000'

SITE LOCATION MAP
SCALE: 1"=1000'

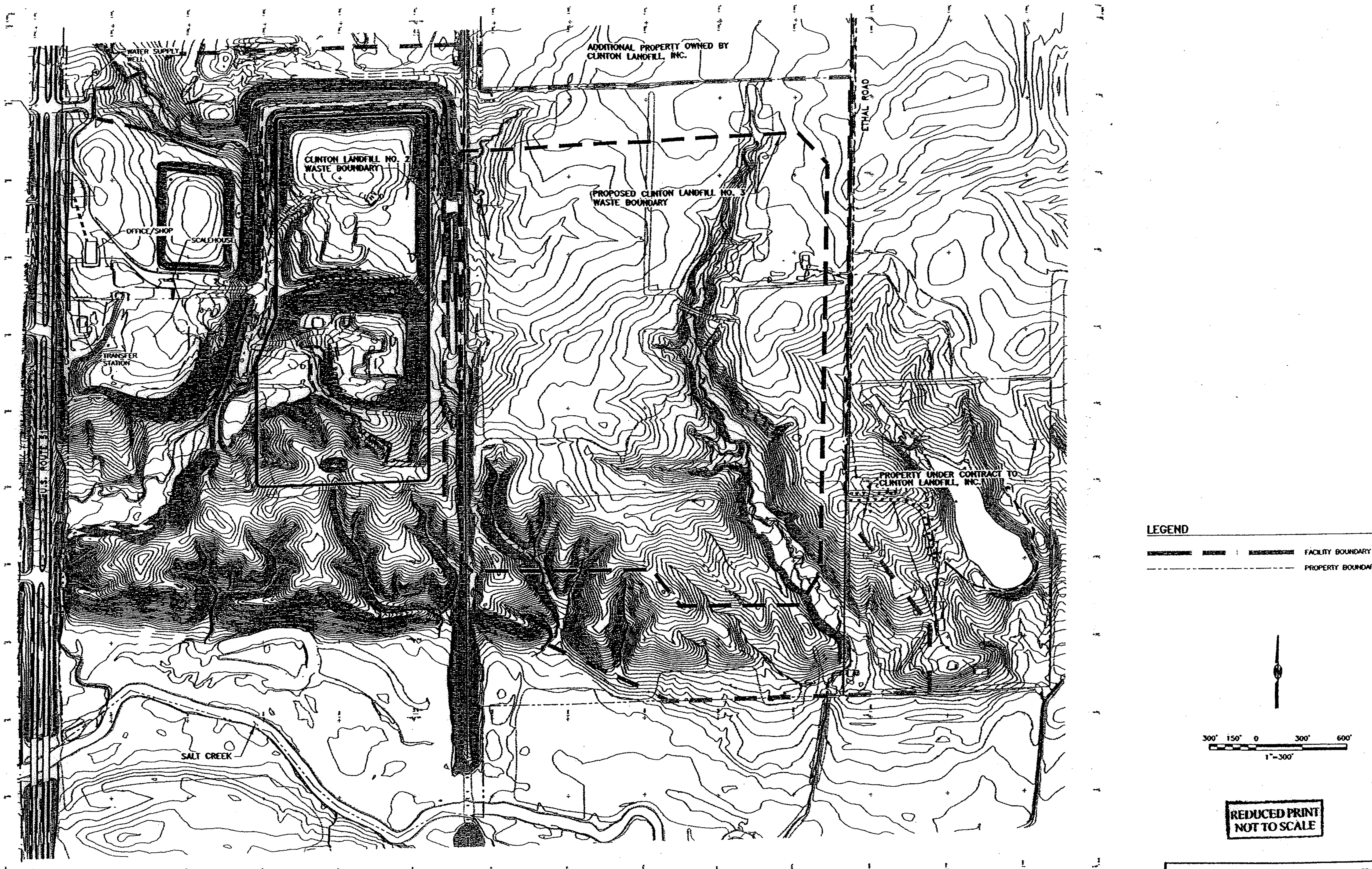
SOURCES: 1. BASE MAPS: CLINTON (2001), MAROA (2001); ILLINOIS QUAD PHOTO MAPS, USGS 7.5' TOPOGRAPHIC MAPS

CLINTON LANDFILL NO. 3

SITE LOCATION MAP

PDC TECHNICAL SERVICES, INC.
PEORIA, ILLINOIS
ILLINOIS LICENSED PROFESSIONAL DESIGN FIRM 184-001145

91-118
J. HERRON
SCALE: AS NOTED
DATE: 2-25-05
NPDES-1



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TOPOGRAPHY SOURCE: WALKER ASSOCIATES, INC., AERIAL PHOTOGRAPHY 3-30-99

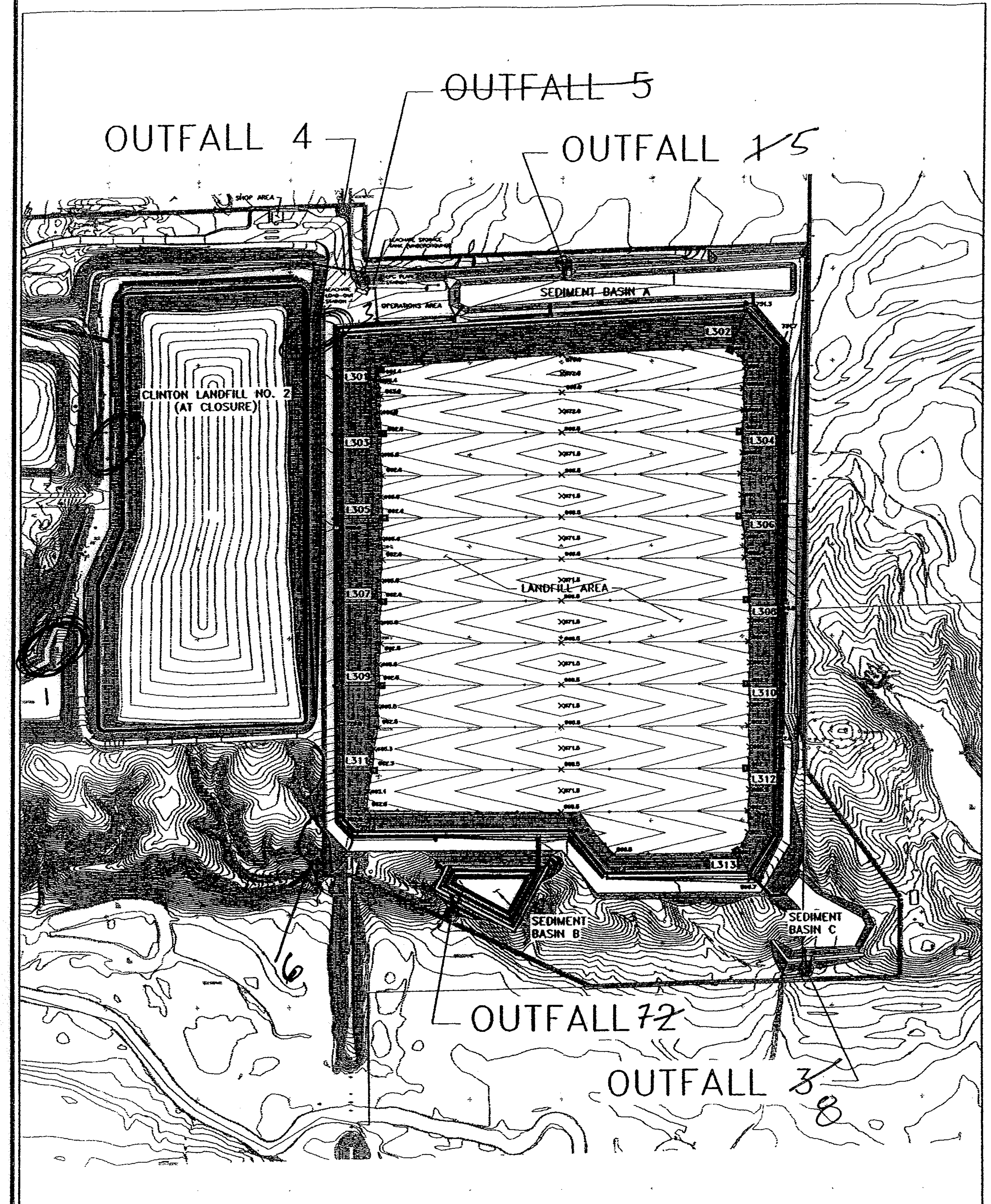
REV. NO.	DATE OF ISSUE	REVISION AND RECORD OF ISSUE	BY	APP.

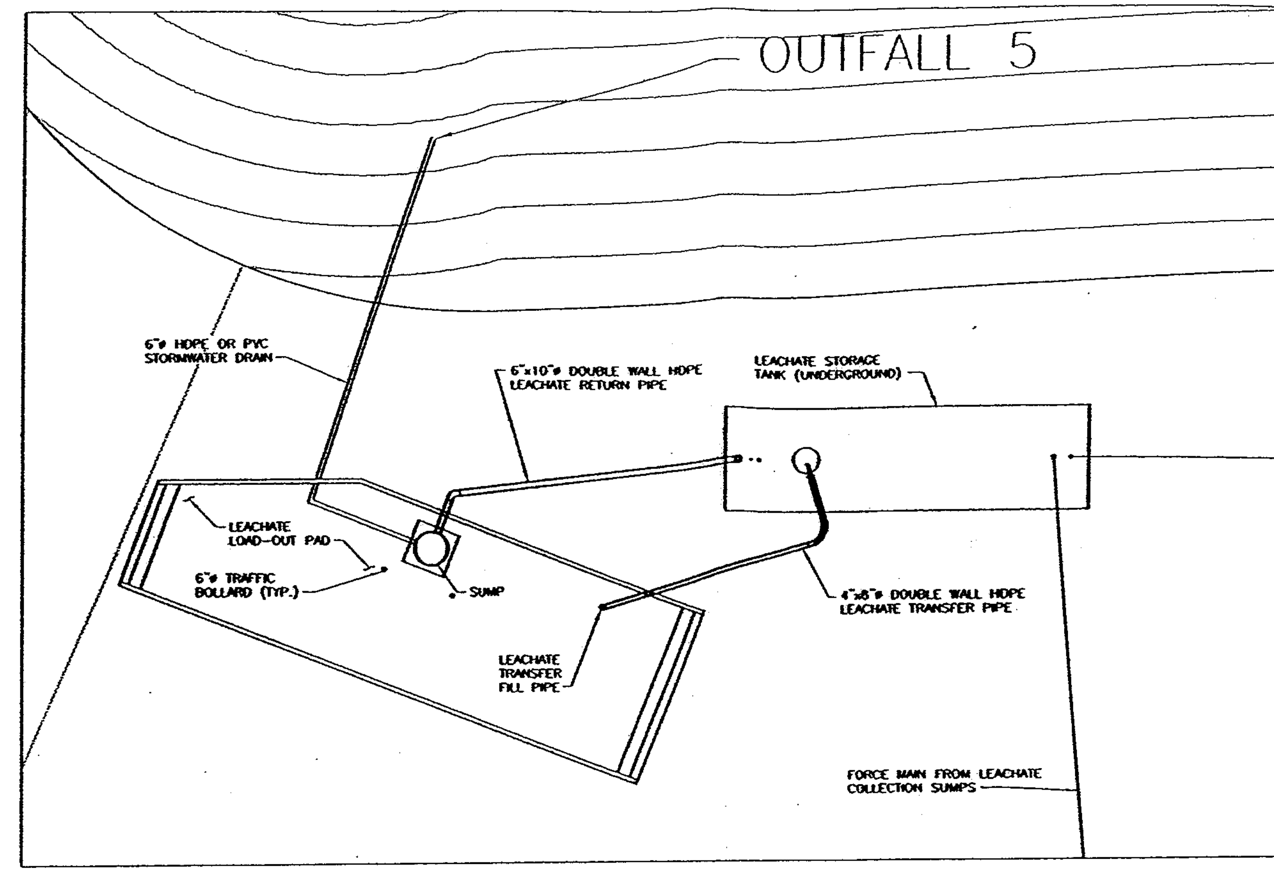
CLINTON LANDFILL NO. 3

EXISTING SITE CONDITIONS

PDC PROJ#: 91-118	PDC TECHNICAL SERVICES, INC. PEORIA, ILLINOIS
DRAWN BY: M. CAMERON	ILLINOIS LICENSED PROFESSIONAL DESIGN FIRM 184-001145
SCALE: AS NOTED	APPROVED BY:
DATE: 2-25-05	DRAWING NUMBER: NPDES-2

CAD DWG NO:91116104I EMPLOYEE NO:19834 DATE/TIME:02/22/05 19:29 ACAD-15





LEACHATE LOAD-OUT PAD/UST AREA DETAIL

SCALE: 1"=10'

LEGEND

- PERFORATED LEACHATE COLLECTION PIPE (6"ø HDPE), WITH FLOW DIRECTION
- LEACHATE RISER (18"ø HDPE)
- UNDERGROUND LEACHATE/CONDENSATE FORCE MAIN (DOUBLE-WALL HDPE)
- LEACHATE COLLECTION SYSTEM PIPE CLEAN OUT RISER (6"ø HDPE)
- WASTE BOUNDARY
- FACILITY BOUNDARY
- ● CONDENSATE LIFT STATION (SEE DETAIL ON DWG. NO. P-LCS5)
- o LEACHATE/CONDENSATE FORCE MAIN JUNCTION/ LEAK DETECTION MANHOLE (SEE DETAIL ON DWG. NO. P-LCS5)
- X971.8 TOP OF GEOMEMBRANE ELEVATIONS

NOTE:

1. CONNECT CLEANOUT RISERS TO LEACHATE COLLECTION PIPE USING LONG-RADIUS FITTINGS.

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200' 100' 0 200' 400'

1"=200'

CLINTON LANDFILL NO. 3

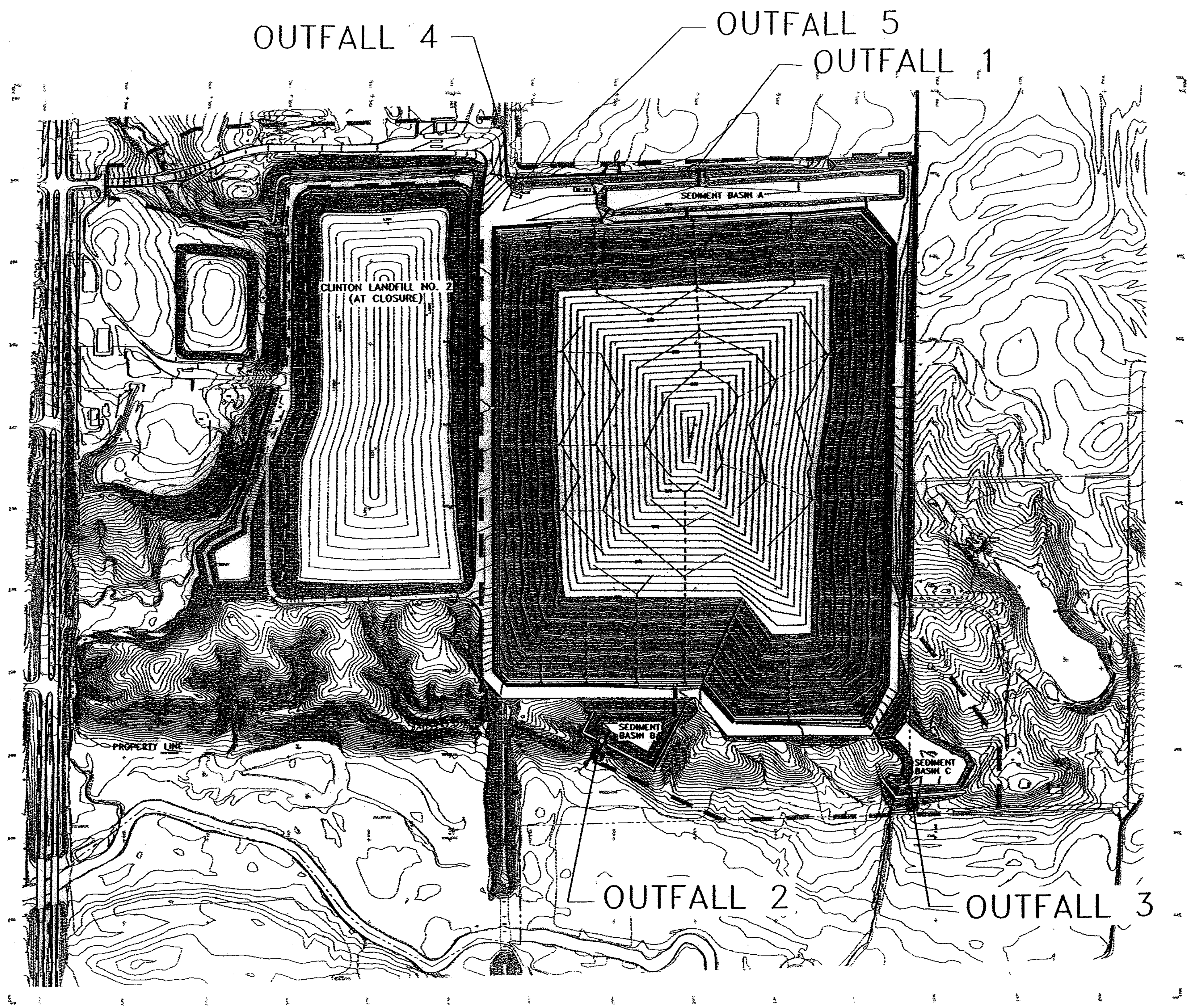
LANDFILL FLOOR PLAN

PDC PROJ.# 91-118.02	PDC TECHNICAL SERVICES, INC. PEORIA, ILLINOIS
DRAWN BY: M. CAMERON	ILLINOIS LICENSED PROFESSIONAL DESIGN FIRM 184-001145
SCALE: 1"=200'	APPROVED BY:
DATE: 02-25-05	DRAWING NUMBER: NPDES-3

REV. NO.	DATE OF ISSUE	REVISION AND RECORD OF ISSUE	BY	APP.

REFERENCE:

BASE TOPOGRAPHY BASED ON AERIAL PHOTOGRAMMETRY BY WALKER AND ASSOCIATES, ST. LOUIS, MISSOURI (MARCH 30, 1999 PHOTOGRAPHY DATE)



LEGEND

	FACILITY SITING BOUNDARY
	PROPERTY BOUNDARY
	STORM WATER DIVERSION BERM
	STORM WATER LETDOWN PIPE
	STORM WATER CULVERT
630	EXISTING TOPOGRAPHIC ELEVATION CONTOUR (FEET MSL)
600	PROPOSED FINAL GRADE ELEVATION CONTOUR (FEET MSL)

300' 150' 0 300' 600'
1"=300'

REFERENCE: BASE TOPOGRAPHY BASED ON AERIAL PHOTOGRAMMETRY BY WALKER AND ASSOCIATES, ST. LOUIS, MISSOURI (MARCH 30, 1999 PHOTOGRAPHY DATE)

REV. NO.	DATE OF REVISION	REVISION AND RECORD OF ISSUE	BY	APP.

CLINTON LANDFILL NO. 3

STORM WATER MANAGEMENT PLAN

PDC PROJ#: 91-118.02	PDC TECHNICAL SERVICES, INC. PEORIA, ILLINOIS
DRAWN BY: M. CAMERON	ILLINOIS LICENSED PROFESSIONAL DESIGN FIRM 184-001145
SCALE: 1"=300'	APPROVED BY:
DATE: 02-25-05	DRAWING NUMBER: NPDES-4

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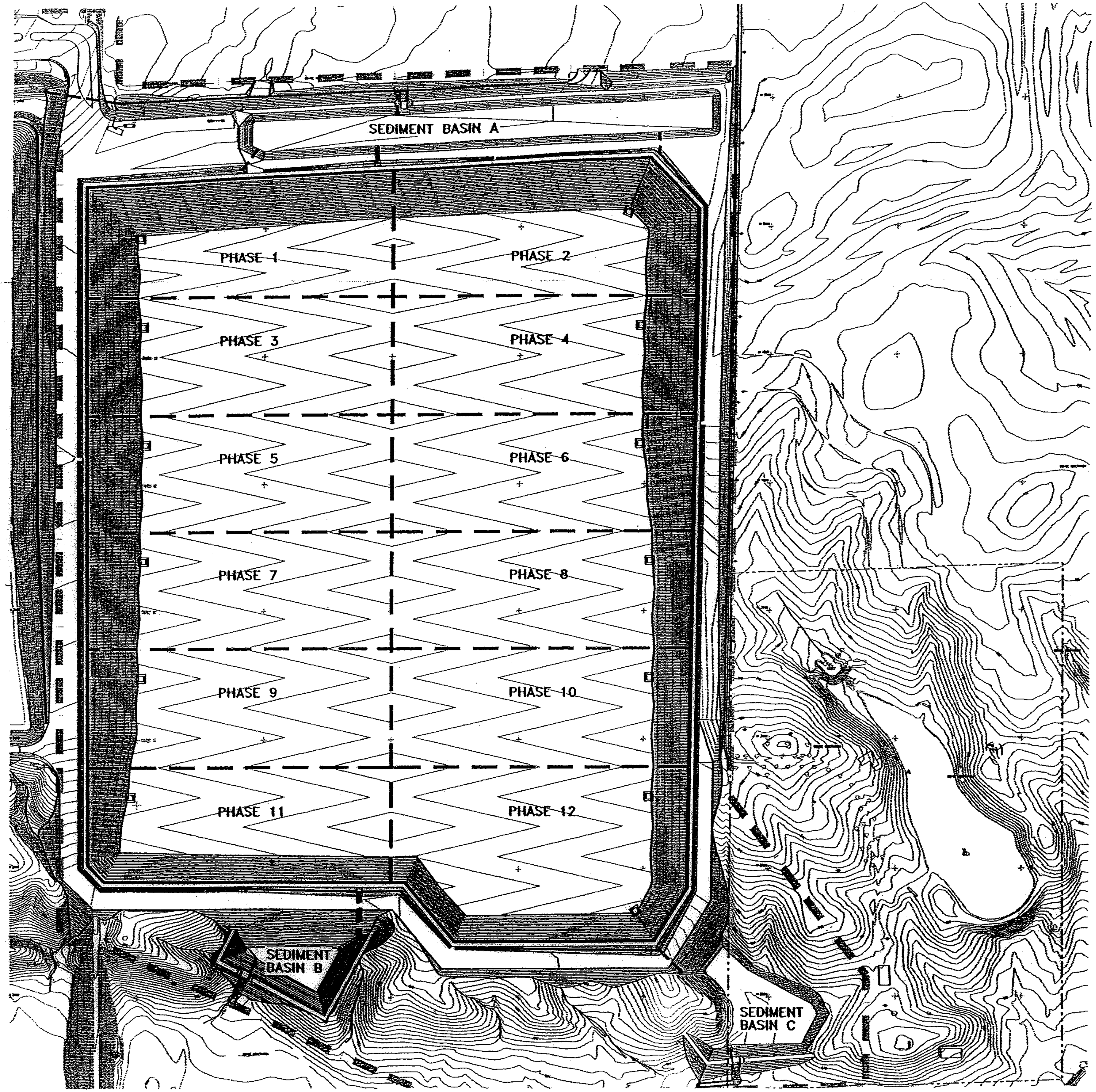


LEGEND

- FACILITY SITING BOUNDARY
- PROPERTY BOUNDARY
- STORMWATER DIVERSION BERM
- STORMWATER LETDOWN PIPE
- STORMWATER CULVERT
- 630 — EXISTING TOPOGRAPHIC ELEVATION CONTOUR (FEET MSL)
- 600 — PROPOSED FINAL GRADE ELEVATION CONTOUR (FEET MSL)

REDUCED PRINT NOT TO SCALE

200 100 0 200 400
1"=200

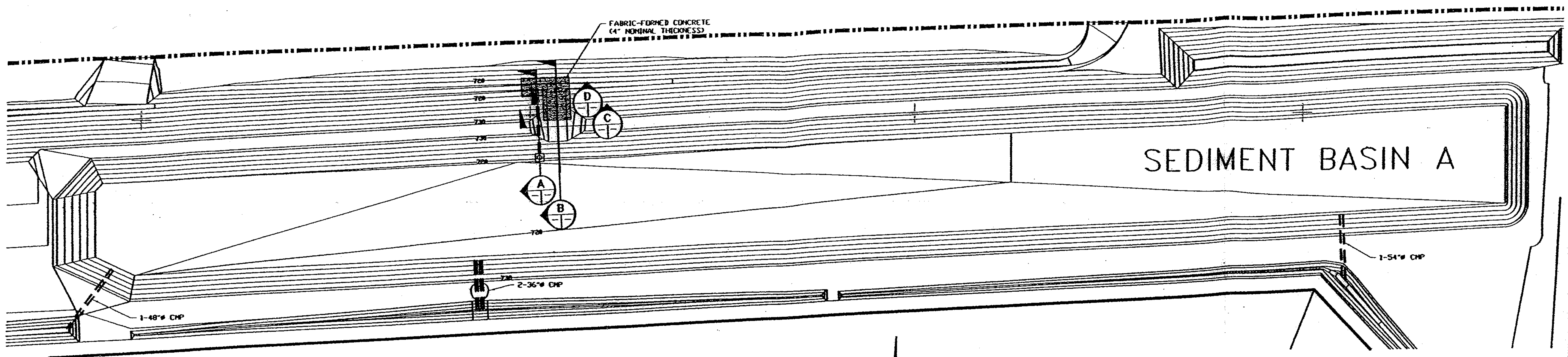
REFERENCE:
BASE TOPOGRAPHY BASED ON AERIAL PHOTOGRAMMETRY BY WALKER AND ASSOCIATES, ST. LOUIS, MISSOURI (MARCH 30, 1999 PHOTOGRAPHY DATE)

REV. NO.	DATE OF ISSUE	REVISION AND RECORD OF ISSUE	BY	APP.

CLINTON LANDFILL NO. 3

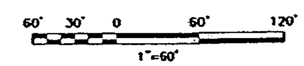
LANDFILL DEVELOPMENT PHASING PLAN

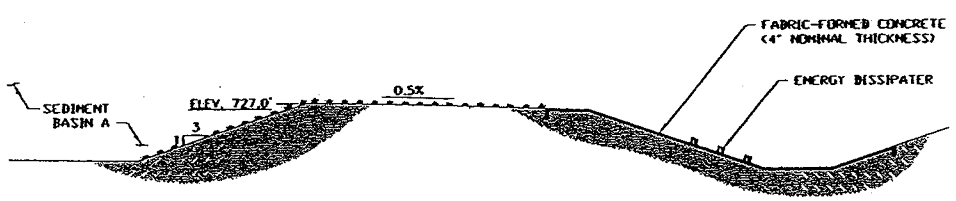
PDC PROJECT 91-118.02	PDC TECHNICAL SERVICES, INC. PEORIA, ILLINOIS ILLINOIS LICENSED PROFESSIONAL DESIGN FIRM 184-001145	
DRAWN BY: M. CAMERON		
SCALE: 1"=200'	APPROVED BY:	DRAWING NUMBER NPDES-5
DATE: 04-11-02		



SEDIMENT BASIN A PLAN

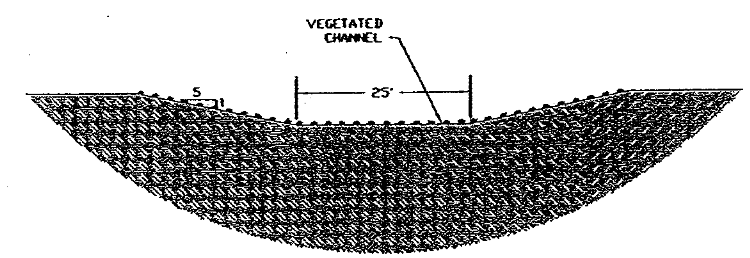
SCALE: 1"=60'





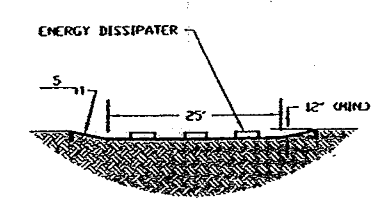
TYPICAL EMERGENCY SPILLWAY PROFILE (B)

NOT TO SCALE



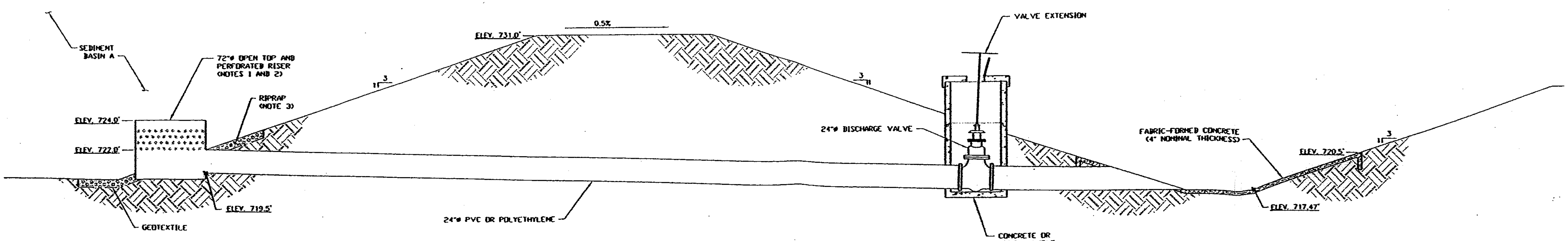
TYPICAL EMERGENCY SPILLWAY SECTION (C)

NOT TO SCALE



OVERFLOW SPILLWAY SECTION (D)

NOT TO SCALE



NOTES:
1. PROVIDE 4 ROWS OF 2"ø PERFORATIONS SPACED 6" VERTICALLY AND RADIALLY. LOWEST ROW SHALL BE AT ELEVATION 722'.
2. PROVIDE ANTI-VORTEX PLATE AND TRASH RACK AT TOP OF RISER.
3. PLACE 8" THICK (NOMINAL) RR3 RIPRAP 5' ALL AROUND BASE OF RISER.

SEDIMENT BASIN A PRIMARY OUTLET WORKS PROFILE (A)

NOT TO SCALE

REV. NO.	DATE OF REVISION	REVISION AND RECORD OF ISSUE	BY	APP.

CLINTON LANDFILL NO. 3

SEDIMENT BASIN A PLAN, SECTIONS AND DETAILS

PDC PROJ.# 91-118	PDC TECHNICAL SERVICES, INC. PEORIA, ILLINOIS
DRAWN BY: J. HERRON	ILLINOIS LICENSED PROFESSIONAL DESIGN FIRM 184-001145
SCALE: AS NOTED	APPROVED BY:
DATE: 2-25-05	DRAWING NUMBER: NPDES-6